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ABSTRACT

This collection of alternative assessment ideas in science includes state assessments, national and international assessments, performance assessments, portfolios, technical innovations, research about assessment, and current thinking on what should be assessed. All entries are alternative, meaning other than standardized and norm-referenced. A coded index is also included. (DDR)

Innovative Assessment

BIBLIOGRAPHY OF ASSESSMENT ALTERNATIVES:

SCIENCE

May 1998 Edition

Northwest Regional Educational Laboratory

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Innovative Assessment

Bibliography of Assessment Alternatives: Science

May 1998 Edition

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BIBLIOGRAPHY OF ASSESSMENT ALTERNATIVES: SCIENCE

May 1998

Our goal is to assure that our citizens know enough about science so that they:

- can tell the difference between sense and nonsense, between science and pseudoscience
- can distinguish the possible from the impossible, the probable from the improbable
- can understand both the powers and limits of science and technology
- are not at the mercy of experts—or worse, of charlatans posing as experts
- can be participants, not victims, in our increasingly and irreversible technological society.

(David Saxon, Massachusetts Institute of Technology, February 17, 1991)

If you'd like to know what neat "goodies" are out there in the realm of alternative assessment, this is the document for you. We've collected hundreds of alternative assessment ideas in science that cover all grade levels. In this bibliography, we include state assessments, classroom assessments, national or international assessments, performance assessments, portfolios, technical innovations, research *about* assessment, and current thinking on what *should* be assessed. Most are very recent—some even published in 1998!

Presence on the list does not necessarily imply endorsement; articles are included to stimulate thinking and provide ideas. By "alternative" we mean "other than standardized, norm-referenced." For more information, contact Matthew Whitaker, Assessment Resource Library Clerk, at (503) 275-9582, Northwest Regional Educational Laboratory, 101 SW Main Street, Suite 500, Portland, Oregon 97204, e-mail: arl@nwrel.org. To purchase a copy of this bibliography, please call NWREL's Document Reproduction Service at (503) 275-9519.

Glossary: In this bibliography, terms are used in the following way: *holistic rubric* = one score based on overall impression; *analytical trait rubric* = performance judged along several dimensions; *task specific rubric* = rubric tailored for a specific task, and *generalized rubric* = rubric used across tasks.

Abraham, Michael R., Eileen Bross Grzybowski, John W. Renner, et al. ***Understandings and Misunderstandings of Eighth Graders of Five Chemistry Concepts Found in Textbooks.*** **Located in: Journal of Research in Science Teaching 29, 1992, pp. 105-120.**

The study reported in this paper looked at how well grade eight students understand five concepts in chemistry: chemical change, dissolution, conservation of atoms, periodicity, and phase-change. There are five problems, one associated with each concept. Each problem describes (and/or shows) a problem situation and asks one to three questions. Some questions require short answers and some require explanations of answers. Each response is scored on a six-point scale of conceptual understanding from "no response" to "sound understanding" of the concept. The paper gives some examples of misunderstandings shown by the students.

The authors found that very few students really understood the concepts. They speculate that this may either be due to the nature of instruction (mostly textbook driven and little hands-on) or because students are not developmentally ready for the formal logic found in these concepts. The paper also reports some information on student status and the relationship between scores on this test and another measure of formal logical thinking.

(AL# 650.3UNDMIE)

Alberta Education. ***Evaluating Students' Learning and Communication Processes,*** **January 1993-January 1994. Available from: The Learning Resources Distributing Centre, 12360—142 St., Edmonton, AB T5L 4X9, Canada, (403) 427-2767, fax (403) 422-9750.**

The goals of the *Evaluating Students' Learning and Communication Processes* program are to: (1) evaluate progress of secondary students (grades 7-10) in six learning and communication processes; (2) integrate the six processes across classes in language arts, social studies, and science; and (3) empower students to take control of learning by making them conscious of the six process skills and how they, themselves, use them. It is based on the premise that students' achievement is directly related to the extent to which they have conscious, independent control over essential learning and communication processes. The six learning and communication processes are: exploring, narrating, imagining, empathizing (understanding the perspectives of others), abstracting (create, support, apply and evaluate generalizations), and monitoring. The materials provide generalized performance criteria (indicators) that serve both to define each process skill and to provide a mechanism for judging the quality of student use of the skill, regardless of the area in which they are working.

There is a general handbook for all subject areas that covers evaluation (performance criteria and recording information) and instruction (how to implement the program, instructional activities for students, help with student self-reflection, help with teacher collaboration, and how to report student progress). There is a separate handbook for each subject area that contains sample teaching units designed to show teachers how to incorporate diagnostic evaluation of students' learning and communication processes into regular instruction. In science the diagnostic teaching units are in the areas of structures/design for grade 7 and acids/bases for grade 10.

The documents give a good rationale for the importance of the six process skills and the importance of student self-monitoring of the processes. They also give extremely good advice on how to design instructional tasks that require students to use the six process skills, how to use instructional tasks as a context for student self-monitoring of process skills, and how to evaluate progress on these skills. The documents are also very useful because they have attempted to define process skills and apply them across subject matter areas. No technical information is provided. Some sample student work is provided.

(AL# 600.3EVASTL)

Ancess, Jacqueline, and Linda Darling-Hammond. ***The Senior Project—Authentic Assessment at Hodgson Vocational/Technical High School*****, September 1994. Available from: The National Center for Restructuring Education, Schools, and Teaching (NCREST), Box 110, Teacher College, Columbia University, New York, NY 10027, fax (212) 678-4170.**

This monograph describes the senior project at Hodgson Vocational/Technical High School. It includes an analytical trait scoring guide (understanding of content, organization, communication skills, personal appearance) and one student research report.

(AL# 150.6SENPRA)

Appalachia Educational Laboratory. ***Alternative Assessments in Math and Science: Moving Toward a Moving Target,*** **1992. Available from: Appalachia Educational Laboratory, PO Box 1348, Charleston, WV 25325, (304) 347-0400.**

This document reports a two-year study by the Virginia Education Association and the Appalachia Educational Laboratory in which twenty-two K-12 science and math teachers designed and implemented new methods of evaluating student competence and application of knowledge. Teachers who participated in the study felt that the changes in assessment methods led to changes in their teaching methods, improvements in student learning and better student attitudes. Instruction became more integrated across subjects, instruction shifted from being teacher-driven to being student-driven, and teachers acted more as facilitators of learning rather than dispensers of information.

Included in the report is a list of recommendations for implementing alternative assessments, a list of criteria for effective assessment, and 22 sample activities (with objectives, tasks, and scoring guidelines) for elementary, middle, and high school students, all designed and tested by the teachers in the study.

Most activities have performance criteria that are holistic and task-specific. No technical information or sample student work is included.

(AL# 600.3ALTASM)

Arter, Judith A. ***Integrating Assessment and Instruction*****, 1994. Available from: Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9582, fax: (503) 275-0450.**

Although not strictly about science assessment, this paper is included because of its discussion of how, if designed properly, performance assessments can be used as tools for learning in the classroom as well as tools for monitoring student progress.

(AL# 150.6INTASI)

Arter, Judith A. ***Performance Criteria: The Heart of the Matter*****, 1994. Available from: Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9582, fax: (503) 275-0450.**

Although not directly related to science assessment, this paper discusses an important issue that pertains to performance assessment in general—the need for clear and well thought out scoring mechanisms. The paper discusses what performance criteria are, the importance of good quality performance criteria, how to develop performance criteria, and keys to success. The author argues for generalized, analytical trait performance criteria that cover all important aspects of a performance and are descriptive.

(AL# 150.6PERCRH)

Badger, Elizabeth, and Brenda Thomas. ***On Their Own: Student Response to Open-Ended Tests in Science*****, 1989-1991. Available from: Massachusetts Educational Assessment Program, Massachusetts Department of Education, 350 Main St., Malden, MA 02148, (617) 388-3300.**

This document contains assessment materials for grades 4, 8, and 12 from three years (1988-1990) in four subject areas (reading, social studies, science and math). In 1988 and 1990 students solved problems and explained their answers. These problems emphasized the major areas of patterns/relationships, geometry/measurement, and numerical/statistical concepts. All problems were written. Responses were scored both for correctness of solution and for quality of the explanation. No specific criteria for judging quality of explanation were given. Several examples of student responses illustrating various conclusions are included.

In 1989, 2,000 students were assigned one of seven performance tasks (four in math required manipulatives) to do in pairs. Each pair was individually watched by an evaluator. It took 65 evaluators five days to observe the 2,000 performances. Evaluators checked off those things that students did correctly (e.g., measure temperature), and recorded students' conversations and strategies. Specific criteria are not included.

Some information on results for all the assessments is provided: percentages of students getting correct answers, using various strategies, using efficient methods, giving good explanations, etc., depending on the task. Many examples of student responses illustrating these various points are provided. No technical information about the assessments themselves is provided.

(AL# 600.3ONTHOS)

Baker, Eva L., Pamela R. Aschbacher, David Niemi, et al. ***CRESST Performance Assessment Models: Assessing Content Area Explanations,*** **April 1992. Available from: National Center for Research on Evaluation, Standards, and Student Testing (CRESST), Center for the Study of Evaluation, UCLA Graduate School of Education, 145 Moore Hall, Los Angeles, CA 90024, (310) 206-1532, fax (310) 825-3883.**

The authors provide two detailed examples of performance assessments for high school students—history and chemistry. In addition to these two specific examples, the document includes help on duplicating the technique with other subject matter areas, including rater training, scoring techniques, and methods for reporting results. The general assessment procedure includes: a Prior Knowledge Measure which assesses (and activates) students' general and topic-relevant knowledge; provision of primary-source/written-background materials; a writing task in which students integrate prior and new knowledge to explain subject matter issues in responses to prompts; and a scoring rubric.

The prior knowledge portion of the chemistry example consists of 20 chemistry terms for which students "write down what comes to mind drawing upon [their] knowledge of chemistry." The "written materials" consist of a description of how a chemistry teacher tests samples of soda pop to determine which contained sugar and which contained an artificial sweetener. The writing task involves assisting a student who has been absent to prepare for an exam.

Scoring is done on a scale of 0-5 for each of: overall impression, prior knowledge, number of principles or concepts cited, quality of argumentation, amount of text-based detail, and number of misconceptions. (The scoring scheme is elaborated upon for the history example, but not for the chemistry example.) Scoring on several of the five-point scales is based on the number of instances of a response rather than their quality. For example, conceptual misunderstanding is scored by counting the number of misunderstandings. Only the "argumentation" scale calls for a strictly quality judgment.

No technical information is included. Sample student responses are provided for the history example but not the chemistry example.

(AL# 000.3CREPEA)

Barnes, Lehman W., and Marianne B. Barnes. ***Assessment, Practically Speaking.*** **Located in: Science and Children, March 1991, pp. 14- 15.**

The authors describe the rationale for performance assessment in science. Traditional tests (vocabulary, labeling, matching, multiple-choice, short-answer, puzzle, questions, essay) accurately assess student mastery of the verbal aspects of science, but they do not allow students to demonstrate what they know.

(AL# 600.6ASSPRS)

Baron, Joan B. ***Performance Assessment: Blurring the Edges Among Assessment, Curriculum, and Instruction,*** **1990. Located in: Champagne, Lovitts and Calinger (Eds.), Assessment in the Service of Instruction, 1990, pp. 127-148. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005, [AAAS Books: (301) 645-5643]. Also in: G. Kulm & S. Malcom (Eds.), Science Assessment in the Service of Reform, 1991, pp. 247-266, AAAS.**

After a brief discussion of the rationale for doing performance assessments in science, this article describes work being done in Connecticut as of 1991.

(AL# 600.6PERASB)

Beaton, Albert E., Michael O. Martin, Ina V. S. Mullis, et al. ***Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*****, November 1996. Available from: TIMSS International Study Center, Center for the Study of Testing, Evaluation, and Educational Policy, Campion Hall, School of Education, Boston College, Chestnut Hill, MA 02167, (617) 552-4521. Internet: http://wwwcsteep.bc.edu/timss**

The Third International Mathematics and Science Study (TIMSS) assessed students in five grade levels in 45 countries. This report covers grades 7 and 8. Data was gathered in 1994 and 1995. The science test covered earth science, life science, physics, chemistry, and environmental issues. About one-quarter of the test items were open-response, some requiring extended responses. TIMSS also gathered extensive contextual information about instruction, resources, and student background.

This report includes 25 sample assessment items of all types and a complete description of results. The context surveys are not included, but can be inferred from the text and tables.

Interesting results were:

- There was a broad range of achievement; the U.S. was in the middle.
- Student achievement in the different content areas varied by curriculum emphasis.
- Boys generally did better than girls.
- Internationally, students did worst in chemistry.
- In most countries, students felt they did well in science, even though this did not always match to actual results.
- Home environment related strongly to achievement; amount of television watched was negatively correlated to achievement.

(AL# 600.6SCIACM)

Bennett, Dorothy. ***Assessment & Technology Videotape,*** **1993. Available from: The Center for Technology in Education, EDC, 96 Morton St., New York, NY 10014, (212) 807-4200.**

This document consists of a video and handbook that focus on the assessment of thinking skills, communication skills and interpersonal skills. The first part of the video describes an alternative assessment system that uses students' personal journals, group logs, projects, and presentations. The group projects and related presentations are the major part of the assessment. The project used as an example requires applying physics to the design of motorized vehicles. Presentations are videotaped and scored by a panel of experts and other students. The second part of the video contains four examples of students' presentations (car wash, tank, garbage truck, oscillating fan) which can be used to practice scoring using the criteria in the handbook. Performances are scored using generalized criteria for thinking skills, communication/presentation skills, and work management/interpersonal skills, by looking at the relative numbers of positive and negative instances of each behavior. Brief descriptions of the criteria are contained in the handbook; they are a little skimpy. Feedback by those attempting to use the criteria is requested.

(AL# 600.3ASSTEVh and 600.3ASSTEVv)

Berenson, Sarah B. and Glenda S. Carter. ***Writing Open-Ended Science Problems.*** **Located in: <u>Science Educator</u> 3, Spring 1994, pp. 23-26. Available from: Dr. Jack Rhoton, East Tennessee State University, Johnson City, TN 37614, (423) 439-1000, fax: (423) 439 5770, Internet: www.etsu-tn.edu**

In this article the authors describe how to develop open-ended questions in science. The procedure was developed through work with grade 3-8 math and science teachers in Granville, North Carolina, to develop assessments for the classroom. The article provides examples of open-ended items that ask students to write stories, offer opinions, write descriptions, and teach science concepts to others. No rubrics are provided. However, the article discusses how teachers might develop expertise in developing rubrics for these open-ended items.

(AL# 600.6WRIOPE)

British Columbia Ministry of Education. ***Performance Assessment: Primary, Early, Late, Intermediate, and Graduate,*** **Draft, August 1992. Available from: Ministry of Education and Ministry Responsible for Multiculturalism and Human Rights, Parliament Buildings, Victoria, BC V8V 2M4, Canada, (250) 387-4611, fax: (250) 356-2504.**

This is a Macintosh disk containing a host of performance assessments developed by the British Columbia Ministry of Education for all grade levels and subject matter areas.

(AL# 000.3BCPERA)

California Assessment Collaborative. ***Charting the Course Toward Instructionally Sound Assessment—A Report of the Alternative Assessment Pilot Project,*** **September 1993. Available from: California Assessment Collaborative, 730 Harrison St., San Francisco, CA 94107, (415) 241-2704.**

The California Assessment Collaborative was designed as a three-year effort to systematically identify, validate, and disseminate alternatives to standardized testing. This report presents findings from the first year for 22 pilot projects including costs, impacts, and recommendations about future work.

The book does an excellent job of placing assessment change into the context of restructuring. It discusses how the following fit together: articulating content standards, monitoring student progress toward goals, building teacher capacity to assess, building student capacity to self-assess, student outcomes, curriculum, and instruction.

(AL# 150.6CHACOU)

California Department of Education. ***Facilitators Guide to Science Assessment,*** **Spring 1995. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101.**

The *Facilitator's Guide to Science Assessment* was developed by teachers, trainers, and the state department of education to:

- Provide teachers with two professional development modules for assisting teachers to better understand and implement authentic assessment in science
- Show the connections among assessment, curriculum, and instruction
- Prepare teachers to develop, administer, and score authentic assessments in their classrooms and to communicate student achievement to students, parents, and other educators
- Highlight the systemic nature of science education reform in California

Phase I is a two-day training that provides teachers new to science assessment with an understanding of the links between quality instruction and authentic assessment, and then provides opportunities to experience and score performance assessment and plan for implementation in their classrooms. Be cautious of the activity Phase I, Part E: Scoring. The authors use specialized definitions for various types of scoring guides that may be confusing to those using other definitions. All needed materials (presenter's outline, handouts, hard copy of overheads) for the two training modules are included.

Phase II is a three-day training that provides teachers experienced with authentic assessment an opportunity to develop and field test their own classroom performance assessment tasks and scoring guides (rubrics) linked to the "big ideas" in the *California Science Framework.*

The guide has excellent sections on (1) comparing multiple choice and performance assessments (including sample performance tasks for elementary, middle, and high school), (2) relating performance assessment to the "big ideas" in science, and (3) designing performance tasks.

(AL# 600.6SCIASS)

California Department of Education. ***Golden State Examination Biology and Chemistry,*** **1993. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101**

The purpose of the Golden State Examination is to identify and recognize students with outstanding achievement in biology, algebra, geometry, US history, chemistry, and economics. This document describes the 1993 biology and chemistry assessments. There are two required sections taking 45 minutes each. The first section is multiple-choice, justified multiple-choice, and short answer. The second section is a laboratory task, performed individually by using materials at testing stations. The open-ended and laboratory tasks are scored using a generic, six-point holistic rubric that is tailored to individual questions. The scoring is based on content knowledge, science process skills, logical thinking, and clear communication. Sample tasks and student responses are included. No technical information is included.

(AL# 600.3GOLSTB)

California Department of Education. ***Golden State Examination Science Portfolio—A Guide for Teachers and Students,*** **1994-95. Available from: California Department of Education, Bureau of Publications, Sales Unit, PO Box 271, Sacramento, CA 95812, (800) 995-4099, fax: (916) 323-0823.**

The GSE *Science Portfolio is* an optional part of California's Golden State Examination, an assessment system designed to place an academic endorsement on students' high school diplomas. Endorsements are available in science, social studies, and language arts. The *Science Portfolio* score is added to the scores on the other portions of the assessment system (multiple choice, short answer, essay, and laboratory), if it improves overall performance.

The *Science Portfolio is* developed during a year of high school biology, chemistry, or integrated science. Content must include a self-generated, problem-solving investigation; a creative expression (expressing a concept in science in an alternative way that enhances meaning, e.g., art, music, writing); and "learning by writing" (a series of pieces that demonstrates growth in understanding). Each of the three parts includes a cover page that asks students why the piece was chosen and requires students to self-reflect on the development process.

Each of the three entries (together with the cover page) is scored with a separate holistic (one score) rubric based on such things as conceptual understanding, group collaboration, and quality of communication. There is also a rubric for scoring the portfolio as a whole. Some technical information is included. Contact the authors for samples of student work.

(AL# 600.3GOLSTE2)

California Department of Education. ***Science—New Directions in Assessment, California Learning Assessment System,*** **1993. Available from: California Department of Education, PO Box 944272, Sacramento, CA 94244, (916) 657-2451, fax: (916) 657-5101**

This document contains the following: five performance tasks (1991 pilot performance tasks for grades 8, and 11, and 1992 performance tasks for grades 5, 8, and 10); a newsletter describing current status of the science portfolio for grades 5, 8, and 10; and an overview of the California Learning Assessment System (CLAS) for 1990-1992. (The CLAS also has an enhanced multiple-choice section that is described, but not illustrated, in this document.) The tasks require some individual and some group work, have multiple questions focusing on a common theme (e.g., recycling or fossils), and require several class periods to complete. Scoring on the tasks in grades 5 and 8 is task specific (on a scale of 0-4 or 0-6); scoring on the grade 10 and 11 tasks uses a general 1-4 point scoring guide that emphasizes understanding, detailed observations, good quality data, good experimental design, organized presentation of data, supported conclusions, and reasonable explanations. Neither technical information nor sample student responses are included. Note: Although CLAS has been discontinued, the document provides many good ideas.

(AL# 600.3SCINED)

Campbell, Linda, Bruce Campbell, and Dee Dickinson. ***Teaching and Learning Through Multiple Intelligences*****, 1996. Available from: Allyn & Bacon, 111 Tenth St., Des Moines, IA 50309, (515) 284-6751, (800) 278-3525.**

This book describes Howard Gardner's "seven intelligences," provides checklists for identifying students' dominant intelligences and working styles, how to set-up a learning environment that stresses each intelligence, instructing students through their strengths, instructional activities that foster the development of various intelligences, designing assessments that allow different ways for students to demonstrate their achievement, and portfolios. The section on assessment stresses the design of performance tasks to accommodate different intelligences. No performance criteria or technical information is provided. Some samples of student work are included.

(AL# 000.6TEAALE)

Center for Talent Development. ***Elementary School Pre-Post Survey*** **and** ***Middle/High School Pre-Post Survey*****, 1993. Available from: Evaluation Coordinator, Center for Talent Development, Northwestern University, Andersen Hall, 2003 Sheridan Rd., Evanston, IL 60208, (708) 491-4979.**

This document contains surveys of student attitudes toward mathematics and science. There are two levels—elementary and middle/high school. It was designed for use with Access 2000 participants who are primarily African-American and Hispanic students in an inner-city public school system and enrolled in a math/science/engineering enrichment program.

(AL# 220.3QUEELM)

Champagne, Audrey, B. Lovitts, and B. Calinger. ***Assessment in the Service of Instruction*****, 1990. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This book is a compilation of eleven papers that address the issue of making assessment a tool for meaningful reform of school science. The book contains papers that cover: an overview of good assessment, national and state assessment initiatives, traditional assessments, innovative assessments (performance, group, portfolio, and dynamic), and experiences in England and Wales. Although some of this material is out of date, the introductory article by two of the editors *(Assessment and Instruction: Two Sides of the Same Coin)* is not; it covers:

1. Reasons for assessing, including instruction, conveying expectations, monitoring achievement, accountability and program improvement.

2. What should be assessed, and the inability of multiple-choice tests to assess the most important aspects of scientific competence: generating and testing hypotheses, designing and conducting experiments, solving multi-step problems, recording observations, structuring arguments, and communicating results; or scientific attitudes—comfort with ambiguity and acceptance of the tentative nature of science.

3. A definition of "authentic" assessment: "An assessment is authentic only if it asks students to demonstrate knowledge and skills characteristic of a practicing scientist or of the scientifically literate citizen." Simply matching the curriculum is not enough, because the curriculum may be lacking.

Other articles from this book that are particularly relevant to this bibliography are described separately.

(AL# 600.6ASSINT)

Clarridge, Pamela Brown, and Elizabeth M. Whitaker. *Implementing a New Elementary Progress Report.* Located in: Educational Leadership, October 1994, pp. 7-9. Also available from: Tucson Unified School District #1, 1010 E. Tenth St., Tucson, AZ 85719.

This paper reports on one district's attempt to revise its report card for grades K-5 using a rubric approach. In grades 1-5, rubrics using four-point scales were developed for five "learner qualities"—self-directed learner, collaborative worker, problem solver, responsible citizen, and quality producer—and eight content areas reading, writing, listening/speaking, mathematics, social studies, science, health, and fine arts. Room is provided on the report card for teacher comments, the basis for judgments about student ability (e.g., classroom observation, portfolios), and teacher/student comments.

The authors describe development and pilot testing, preliminary responses from parents and students, plans for revision, and insights (such as "this approach to reporting requires a thorough understanding of the curriculum by both parents and teachers").

(AL# 150.6IMPNEE)

Coalition of Essential Schools. Various articles on exhibitions of mastery and setting standards, 1982-1992. Available from: Coalition of Essential Schools, Brown University, Box 1969, One Davol Sq., Providence, RI 02912, (401) 863-3384.**

Although not strictly about science, this series of articles is useful in general because they discuss the following topics: good assessment tasks to give students, the need for good performance criteria, the need to have clear targets for students that are then translated into instruction and assessment, definition and examples of performance assessments, brief descriptions of some cross-disciplinary tasks, the value in planning performance assessments, and the notion of planning backwards (creating a vision for a high school graduate, taking stock of current efforts to fulfill this vision, and then planning backward throughout K-12 to make sure that we are getting students ready from the start).

(AL# 150.6VARARD)

Collins, Allan, Jan Hawkins, and John R. Frederiksen. *Three Different Views of Students: The Role of Technology in Assessing Student Performance, Technical Report No. 12,* April 1991. Available from: Center for Technology in Education, Bank Street College of Education, 610 W. 112th St., New York, NY 10025, (212) 875-4550, fax: (212) 316-7026. Also available from ERIC: ED 337 150.

This paper begins by discussing why assessment in science is changing: if tests emphasize facts and limited applications of facts, the curriculum will be narrowed to these goals. The paper then gives several good examples of how past high-stakes uses of such tests had negative, unintended side effects on curriculum and instruction.

The authors use the term "systemically valid" to refer to assessments that are designed to create the learning they also assess. The authors discuss four criteria for "systemically valid" tests: (1) the test directly measures the attribute of interest, (2) all relevant attributes are assessed, (3) there is high reliability, and (4) those being assessed understand the criteria. They also discuss criteria for quality tasks, examples of alternative assessment ideas, cost, cheating, and privacy.

(AL# 600.6THRDIV)

Collins, Angelo. *Portfolios for Science Education: Issues in Purpose, Structure, and Authenticity.* Located in <u>Science Education</u> 76, 1992, pp. 451-463.

The author teaches preservice science teachers. This paper discusses design considerations for portfolios in science and applies these considerations to portfolios for student science teachers, practicing science teachers, and elementary students. The design considerations the author suggests are:

1. Determine what the portfolio should be evidence of, i.e., what will the portfolio be used to show?

2. Determine what types of displays should go in the portfolio to provide evidence of #1. The author suggests and describes several types: artifacts (actual work produced), reproductions of events (e.g., photos, videotapes), attestations (documents about the work of the person prepared by someone else), and productions (documents prepared especially for the portfolio such as self-reflections).

3. View the portfolio as a "collection of evidence" that is used to build the case for what is to be shown. Those developing the portfolio should determine the story to be told (based on all the evidence available) and then lay this out in the portfolio so that it is clear that the story told is the correct one.

(AL# 600.6PORSCE)

Colorado Department of Education. ***Standards & Assessment Resource Bank, Version 2.0*****, July 1997. Available from: Colorado Department of Education, 201 E. Colfax Ave., Denver, CO 80203, (303) 866-6915, fax: (303) 830-0793. Internet: Resource_Bank@cde.state.co.us**

This CD-ROM includes more than 40 teacher-developed classroom units and assessments aligned to the Colorado State Model Content Standards, "updated information about the Colorado Student Assessment Program, student art work from the Cherry Creek Arts Festival, standards developed by Cherry Creek and Summit County school districts, information about Douglas County's district assessments, and many more quality items designed to support your implementation of standards-based education."

(AL# 000.3STAASR)

Comfort, Kathleen B. ***The Cost of Performance Assessment in Science: The California Perspective.*** **Paper presented as part of the symposium "The Cost of Performance Assessment in Science" at the 1995 annual meeting of the National Council of Measurement in Education in San Francisco, CA, April 1995.**

This paper analyzes the cost of (a) California's 1993 field test of three indepth investigations (one at each of grades 5, 8, and 10; each took three 60-minute periods, involved a series of hands-on tasks, and were scored both holistically and by component), and (b) research level (grades 5, 6, 8, and 10, containing enhanced multiple-choice, justified multiple-choice, and open-ended items). The author determined that cost per student (for development, administration, scoring, reporting) was $1.67. The paper finishes by explaining why this figure seems to be less than figures from assessments in others places.

(AL# 600.6COSPEC)

Comfort, Kathy. ***A Sampler of Science Assessment—Elementary*****, Preliminary Edition, January 1994. Available from: California Department of Education, Bureau of Publications, Sales Unit, PO Box 271, Sacramento, CA 95812, (800) 995-4099, fax: (916) 323-0823.**

Between 1989 and 1994, the California Learning Assessment System (CLAS) developed and field tested a range of new assessments in science, including performance tasks, enhanced multiple-choice items, open-ended and justified multiple-choice questions, and portfolios. These assessments were designed to provide students the opportunity to demonstrate conceptual understanding of the big ideas of science, to use scientific tools and processes, and to apply understanding of these big ideas to solve new problems.

In "performance tasks," students are provided with hands-on equipment and materials and are asked to perform short experiments, make scientific observations, generate and record their data, and analyze their results. "Open-ended questions" require students to respond by writing a short paragraph, drawing a picture, or manipulating data on a chart or a graph. "Enhanced multiple-choice" items require students to think through the big ideas of science. In justified multiple-choice questions, students may justify or briefly write why they chose their answer. The 1994 grade 5 assessment consisted of three components (8 enhanced and 2 justified multiple-choice items, and a performance assessment).

Scoring occurs in a variety of fashions. For example, the 1994 grade 5 assessment was scored using a four-point, holistic guide for the open-ended questions and a "component guide" for the performance tasks, in which similar items on a task are grouped and scored together. Samples of student work are included.

(AL# 600.3SAMSCA)

Comfort, Kathy. ***A Sampler of Science Assessment*****, Winter 1994-95. Available from: California Department of Education, Bureau of Publications, Sales Unit, PO Box 271, Sacramento, CA 95812, (800) 995-4099, fax: (916) 323-0823.**

This sampler provides information about the 1994 science assessments conducted in grades 5, 8, and 10—examples of questions (enhanced multiple choice, open-ended, and performance-based); scoring guides; and samples of student work. Scoring is task-specific based on a general "scoring guide shell" that emphasizes conceptual understanding of content, clear communication, and skill with science process skills (such as data manipulation and sound conclusions). Overall student achievement is reported in terms of six "performance levels."

(Note: The California Learning Assessment System, for which these assessments were developed, has been replaced by norm-referenced, standardized tests in 1996. However, the assessments can still provide good ideas for others.)

(AL# 600.6SAMSCA3)

Conley, David T., and Christine A. Tell. ***Proficiency-Based Admission Standards,*** **January 8, 1995. Available from: PASS Project, Oregon State System of Higher Education, Office of Academic Affairs, PO Box 3175, Eugene, OR 97403, (503) 346-5799.**

This paper describes the Oregon Board of Higher Education's new policy on admitting students by demonstration of competencies rather than number of courses taken or GPA. Included is the rationale for the approach (including the incongruity between traditional college admissions procedures and the attempt by K-12 schools to restructure), a list of the competencies, ideas for assessment, ideas for how high schools might need to change in order to ensure students meet admissions standards, and commonly asked questions. Competencies include content standards for subject areas (science, math, etc.), as well as basic and process skills standards (writing, reading critical thinking, etc.).

The paper addresses the concern that needed changes in K-12 education will be harder if students are still admitted to college using traditional methods. The authors point out that similar changes in college admissions policy are occurring in many places.

(AL# 150.6PROBAA)

Council of Chief State School Officers. ***The Collaborative Development of Science Assessments: The SCASS Experience,*** **June 1995. Available from: Rolf K. Blank, Director, Education Indicators Program, CCSSO/SEAC, One Massachusetts Ave. NW, Suite 700, Washington, DC 20001.**

This document describes the efforts of a consortium of 14 states to develop assessments in science, including: multiple-choice, short answer, extended response, performance tasks and portfolios. For middle school students there are:

Modules which consist of a scenario (a set-up or passage) followed by six related selected response questions, one short answer question, and one extended response question.

Performance events designed as kit-based activities to be done by small groups of students in a single class period. Some performance events are wet labs while others are paper-and-pencil projects.

Performance tasks designed as individual student projects that occur outside of the classroom setting with some classroom time used in support. These tasks should take place over several weeks.

Example of each type is included in the document. The document does not discuss how performance on these tasks is scored.

The portfolio (designed for grades 4, 8, and 10) contains four types of entries:

1. **Experimental research entry** that shows students (a) understand how scientists work, (b) understand and use the scientific method, and (c) use habits of mind similar to those of a scientist.

2. **Non-experimental research entry** that illustrates the kind of research citizens might do in investigating an issue of personal or societal significance and making a decision.

3. **Creative entry** that asks students to communicate a scientific concept using any creative mode of the student's choosing.

4. **Written entry** that is a critique or persuasive piece.

Additionally, students are asked to reflect on the work illustrated through the other four entries in the portfolio. Criteria were developed for the portfolios, but they are not included in this document.

The document also discusses staff development, opportunity to learn, and includes surveys for students and teachers that ask about classroom structure, content, and approach.

(AL# 600.3COLDES)

CTB McGraw-Hill. ***CAT/5 Performance Assessment Component, 1992.*** **Available from: CTB/McGraw-Hill, 20 Ryan Ranch Rd., Monterey, CA 93940, (800) 538-9547, fax (800) 282-0266.**

The "CTB Performance Assessments" are designed to either be stand-alone or integrated with the CAT/5 or CTBS/4. There are five levels for grades 2-11. The total battery includes reading/language arts, mathematics, science, and social studies and takes 2-3 hours to administer. There are 12-25 short- to medium-response questions for each subtest. The math and science subtests take 30-40 minutes. (For the CAT/5 there is a checklist of skills that can be used at grades K and 1.)

Some questions are grouped around a common theme. Many resemble multiple-choice questions with the choices taken off. For example, questions on one level include: "What are two ways that recycling paper products helps the environment?" "This table shows the air temperatures recorded every two hours from noon to midnight...At what time did the temperature shown on the thermometer most likely occur?" and "These pictures show some of the instruments that are used in science...List two physical properties of the water in the jar below that can be measured with the instruments shown in the pictures. Next to each property, write the name of the instrument or instruments used to measure the property."

Some of the answers are scored right/wrong and some are scored holistically. The materials we received contained no examples of the holistic scoring so we are unable to describe it. Scoring can be done either locally or by the publisher. When the *Performance Assessments* are given with the CAT/5 or CTBS/4, results can be integrated to provide normative information and scores in six areas. There are only three, however that use the math and science subtests: demonstrating content and concept knowledge, demonstrating knowledge of processes/skills/procedures, and using applications/problem-solving strategies. When the *Performance Assessments* are given by themselves, only skill scores are available.

The materials we received contain sample administration and test booklets only. No technical information or scoring guides are included.

(AL# 060.3CAT-5a)

CTB McGraw-Hill. *CTBS—Terra Nova*, 1997. Available from: CTB/McGraw-Hill, 20 Ryan Ranch Rd., Monterey, CA 93940, (800) 538-9547, fax (800) 282-0266.

The 1997 *CTBS/Terra Nova* comes in several mix and match options:

- The traditional, quick and dirty, multiple-choice *Survey Test*—all subjects *or* just the basic skills
- The longer, more diagnostic *Complete Battery*
- Either of the above can have added targeted subtests called the "Plus" version
- *Multiple Assessments* which mix multiple-choice and short constructed-response items
- More performance-based items with extended responses centering on a theme.

All versions, except the *Performance Tasks*, are normed. This review emphasizes the *Multiple Assessments* because the constructed response aspect fits into the nature of this bibliography. (The *Performance Tasks* are reviewed in another entry.)

One especially nice feature is the *Reviewer's Edition* of the *Multiple Assessments* which shows reduced pages from the test, annotated with the rationale for items and formats, skills assessed, and other notes extremely useful for reviewing the assessments. Constructed response science items generally require short answers and emphasize knowledge and application of knowledge. I could find no information on how constructed response questions are scored. In general, the tests are of high quality and the publisher clear about what each format can and cannot assess.

(AL# 060.3TERNOV)

Curriculum Corporation. ***Science—A Curriculum Profile for Australian Schools*** **and** ***Using the Science Profile,*** **1994. Available from: Curriculum Corporation, St. Nicholas Pl., 141 Rathdowne St., Carlton, Victoria, 3053, Australia, (03) 639-0699, fax (03) 639-1616.**

These documents represent the science portion of a series of publications designed to reconfigure instruction and assessment in Australian schools. The project, begun in 1989, was a joint effort by the States, Territories, and Commonwealth of Australia, initiated by the Australian Education Council. The profiles are not performance assessments, per se, in which students are given predeveloped tasks. Rather, the emphasis has been on conceptualizing major student outcomes in each area and articulating student development toward these goals using a series of developmental continuums. These continuums are then used to track progress and are overlaid on whatever tasks and work individual teachers give to students.

The science profiles cover the strands of: earth and beyond, energy and change, life and living, natural and process materials, and working scientifically. Each strand is divided into sub-areas called "organizers." For example, the organizers for the strand of "working scientifically" are: planning investigations, conducting investigations, processing data, evaluating findings, using science, and acting responsibly. Each organizer is tracked through eight levels of development. For example, the organizer "processing data" has "talks about observations and suggests possible interpretations" at Level 1, and "demonstrates rigor in handling of data" at Level 8.

There are lots of support materials that describe what each strand means, how to organize instruction, types of activities to use with students, and how to use the profiles to track progress. Some samples of student work are included to illustrate development. The documents say that the levels have been "validated," but this information is not included in the materials we received.

(AL# 600.3SCICUA)

Curriculum Corporation. ***Technology—A Curriculum Profile for Australian Schools,*** **1994. Available from: Curriculum Corporation, St. Nicholas Pl., 141 Rathdowne St., Carlton, Victoria, 3053, Australia, (03) 639-0699, fax (03) 639-1616.**

This document represents the technology portion of a series of publications designed to reconfigure instruction and assessment in Australian schools. The project, begun in 1989, was a joint effort by the States, Territories, and Commonwealth of Australia, initiated by the Australian Education Council. The profiles are not performance assessments, per se, in which students are given predeveloped tasks. Rather, the emphasis has been on conceptualizing major student outcomes in each area and articulating student development toward these goals using a series of developmental continuums. These continuums are then used to track progress and are overlaid on whatever tasks and work individual teachers give to students.

The technology profiles cover the major strands of: designing, making and appraising, information, materials, and systems. Each strand is broken down into sub-areas called "organizers." For example, the organizers for "designing, making and appraising" are investigating, devising, producing, and evaluating. Each organizer is tracked through eight levels of development. For example, "evaluating" goes from "describes feelings about own design ideas, products, and processes" at Level 1 to "analyzes own products and processes to evaluate the effectiveness of methodologies used and the short and longer-term impact on particular environments and cultures" at Level 8.

There are lots of support materials that describe what each strand means, how to organize instruction, types of activities to use with students, and how to use the profiles to track progress. Samples of student work are included to illustrate development. The document says that the levels have been "validated," but this information is not included in the materials we received.

(AL# 600.3TECCUA)

Doig, Brian, Jill Cheeseman, and John Lindsey, Eds. ***Exemplary Assessment Materials—Science*****, 1995. Available from: Board of Studies, The Australian Council for Educational Research Limited, 19 Prospect Hill Rd., Camberwell, Melbourne, Victoria 3124, Australia. International telephone: +61 3 277-5555, fax: +61 3 277-5500.**

The author proposes that we take a balanced approach to assessment—different purposes and instructional goals require a range of task types: short response, explaining conceptual understanding, practical tasks, and investigations. The publication includes 18 samples organized by grade level and student outcomes. All scoring is task specific. No technical information is included.

(AL# 600.3EXEASM)

Doolittle, Allen E. ***The Cost of Performance Assessment in Science: The SCASS Perspective,*** **1995. Available from: American College Testing, 2201 N. Dodge St., PO Box 168, Iowa City, IA 52243, (319) 337-1086, fax (319) 339-3021.**

The author makes estimates ranging from $11 to $14 per student to conduct a hands-on performance assessment in science. For his estimates, the author used performance tasks being developed by the State Collaborative on Assessment and Student Standards (SCASS) that were hands-on and took 30-55 minutes to administer. Estimates included development, administration, and scoring costs.

(AL# 600.6COSPES)

Doran, Rodney, Joan Boorman, Fred Chan, et al. ***Assessment of Laboratory Skills in High School Science,*** **1991. Available from: Graduate School of Education, University of New York at Buffalo, Buffalo, NY 14260, (716) 645-2455.**

This document consists of four manuals (Biology, General Science, Chemistry, and Physics), and two overview presentations (Alternative Assessment of High School Laboratory Skills and Assessment of Laboratory Skills in High School Science). These describe a series of on-demand activities to assess high school student laboratory skills in science, and a study examining test reliability, inter-rater agreement, and correlations between different parts of the tests.

Six hands-on tasks are presented in each content area manual (biology, chemistry, physics). Each task has two parts. In Part A, students are given a problem to solve and are directed to state an appropriate hypothesis, develop a procedure for gathering relevant observations or data and propose a method for organizing the information collected. After 30 minutes their plans are collected. Plans are scored on three experimental design traits: statement of hypothesis, procedure for investigation, and plan for recording and organizing observations/data. In Part B students are given a predeveloped plan to collect information on the same questions as in Part A. They have 50 minutes to carry out the plan and compose a written conclusion. Performance on Part B is scored for quality of the observations/data, graph, calculations, and conclusion. This procedure ensures that success on Part B is not dependent on Part A. Scoring is designed to be generic: the same criteria are used across tasks. Individual tasks also have specific additional criteria.

The *General Science* test has six tasks set up in stations. Students spend ten minutes at each station. Students answer specific questions that are classified as planning, performing, or reasoning. Scoring is not generalized; points are awarded for specific answers.

All manuals include complete instructions for administering and scoring the tests. Only a few sample student responses are provided. Results from a study done with 32 high schools in Ohio showed that rater agreement was good, it was a very time-consuming process, and teacher reactions varied widely.

(AL# 600.3ASSLAS)

Druker, Stephen L., and Richard J. Shavelson. ***Effects of Performance Assessment and Two Other State Policy Instruments on Elementary School Teachers' Implementation of Science Reform Goals—DRAFT,*** **April 1994. Available from: University of California, Santa Barbara, Graduate School of Education, Santa Barbara, CA 93106.**

The authors studied the impact on four elementary school teachers of (a) *The Science Framework for California Public Schools,* (b) the California Science Implementation Network (CSIN), an organization intended to train teachers to implement the framework's goals for hands-on science teaching in their schools; and (c) the pilot phase of the California Assessment Program's (CAP) statewide performance-based assessment in science which has been mandated by the state to assess the goals of the framework. (Note: California's assessment system is currently being revised.)

These teachers were interviewed several times, classroom materials were reviewed (quizzes, tests, curriculum, instructional materials, and worksheets), and teachers were observed during instruction. Conclusions are:

- Reformers may hold unrealistic goals for performance assessment and curriculum frameworks. For example, the expectation that performance assessment will highlight exemplary teaching for teachers fails to recognize that teachers' perspectives will influence what parts of the testing situation they will choose to model.
- Large differences in how teachers were influenced by the curriculum frameworks and performance assessments were observed.
- The teachers who will use information in the manner that the reform intends are those who already have beliefs about teaching and learning which are aligned with reform.
- Putting performance assessments in place, articulating systemwide plans, and providing model curriculums may not be sufficient to change teachers basic beliefs and practices. Given the complexity of this task, professional development needs to provide teachers with more opportunities to explore, confront, and change their current belief systems and to actively struggle with issues of how to implement reform goals in their classrooms.

(AL# 600.6EFFPEA)

Educational Testing Service. *Capturing the Power of Classroom Assessment.* Located in: <u>Focus</u> 28, 1995. Available from: ETS, Mail Stop 16-D, Rosedale Rd., Princeton, NJ 08541.

Even though the content of this pamphlet is a little more constrained than the title might imply, there is still useful content. There is a nice succinct statement of why classroom assessment is changing, and good descriptions of three classroom alternative assessments: kid watching, Arts PROPEL portfolios, and SEPIA science portfolios. This pamphlet might be useful for parent groups.

(AL# 150.6CAPPOC)

Educational Testing Service. *Miscellaneous alternative assessments,* 1993. Available from: Educational Testing Service, 1979 Lakeside Pkwy, Suite 400, Tucker, GA 30084, (404) 723-7424.

Six teams of elementary and middle schools in Georgia, in conjunction with the ETS Southern Field Office in Atlanta, are working on math and science assessment activities (cooperative group, videotape, open-ended experiments) that can be used across grades and content areas, and that are designed to assess science process skills, math problem solving, ability to communicate in science and math, and content knowledge.

The materials we have include scoring guides (both general and task-specific, and holistic and analytical trait) and scored samples of student work. No technical nor contextual information is included in the materials (although such information is available from the publisher). Any use requires permission from Educational Testing Service.

(AL# 000.3MISALA)

Everett, Robert. ***Performance Assessment Workshops in Mathematics and Science,*** **1994. Available from: University of Central Florida, College of Education, Orlando, FL 32816, (407) 823-5788.**

These training materials were developed for K-8 teachers to help them use performance assessments in math and science. Science process skills are assessed using a holistic, five-point, generic rubric that covers problem solving, reasoning, process skills, communication, connections, and content knowledge. Sample tasks include conducting an experiment with paper towels, organizing data from a table, and writing explanations of math applications.

(AL# 600.6PERASW2)

EXEMPLARS. ***EXEMPLARS—A Teacher's Solution: Science Preview Kit, Science Volume 1, Number 2, March 1997.*** **Available from: EXEMPLARS—A Teacher's Solution, 271 Poker Hill Rd., Underhill, VT 05489, (800) 450-4050, fax: (802) 899-4825, Internet: http://www.exemplars.com**

EXEMPLARS is a bank of constructed response science tasks for grades K-8, keyed to several national sets of content standards. The goal is to help teachers implement standards-based assessment. Tasks are designed and pilot tested by teachers and require students to:

- Develop a strategy
- Use scientific tools
- Communicate their understanding
- Use scientific terms appropriately
- Connect on what they're doing to the "big" ideas of science

Tasks require the use of manipulatives; most responses are written and/or pictures. A general, four-trait rubric is provided to score student work. Each trait is scored using a four-point scale—novice, apprentice, practitioner, and expert. The traits are:

- Scientific tools and technology
- Scientific reasoning and procedures

- Scientific communication and using data
- Conceptual understanding

I like this one. Although the general rubric itself is a little skimpy, it is more than compensated for by the rich connections made, scored samples of student work, task-specific renderings of the general criteria, and instructional tips for students at each level.

(AL# 600.3EXETES)

Far West Laboratory for Educational Research and Development. ***Evaluation of GALAXY Classroom Science for Grades 3-5—Final Report*****, December 1994. Available from: WestEd, 730 Harrison St., San Francisco, CA 94107, (415) 565-3000.**

The authors report on an evaluation of the GALAXY science program for grades 3-5 students. For our purposes, the interesting part of the document was the hands-on assessments and questionnaires designed to assess student knowledge. (These are included in the document.) Two of the tasks used pre-post (fossils and leaves), were designed to be parallel and to assess: (1) making and recording observations, (2) comparing similarities and differences, (3) understanding relationships, and (4) classifying. The other two parallel tasks (rocks and soils) also used pre-post, were designed to assess: (1) design and perform experiments, and (2) analyze and extend results. All scoring is task-specific. Data from the groups studied is reported.

(AL# 600.6EVAGAC)

Far West Laboratory for Educational Research and Development. ***Focus on Educational Resources, Spring 1995; Knowledge Brief, Number 12, 1995; Knowledge Brief, Number 11, 1993.*** **Available from: WestEd, 730 Harrison St., San Francisco, CA 94107, (415) 565-3000.**

This set of documents from 1993 to 1995 discusses the following topics:

- The ways in which assessments can mask the achievement of culturally diverse students instead of highlighting them

- The hopes and fears associated with the use of alternative assessments and culturally diverse students

- Examples of assessment tasks and their language demands which place extra constraints on ESL students

- Examples of how community members in Chinle, Arizona, modified assessment tasks to be more culturally relevant

(AL# 150.6ISSCRA)

Fort Hays Educational Development Center, The. ***Science Rubrics Training,*** **1994. Available from: Steve Nolte, The Fort Hays Educational Development Center, 305 Picken Hall, Hays, KS 67601, (913) 628-4382, fax (913) 628-4084.**

The 1995 Kansas science assessment for grades 5, 8, and 11 has three parts: multiple choice, multiple mark, and performance based. The performance-based assessment consists of classroom-embedded problem-solving tasks. Overall specifications for the tasks are provided by the state, but teachers are responsible for designing specific activities. Student performance is scored using four traits: recognizing and defining the problem, designing the problem-solving strategy, implementing the problem-solving strategy, and implementing/communicating findings and conclusions.

This document is a set of materials developed by The Fort Hays Educational Development Center to train educators in its region on the Kansas state assessment. The document includes handouts from the training—rationale for the assessment, how to design meaningful group work, the science assessment rubrics, sample multi-step test questions, a sample performance-based project and student work samples, instructions for designing the group project, and Kansas science curriculum standards.

(AL# 600.3SCIRUT)

Fraser, Barry J., Geoffrey J. Giddings, and Campbell J. McRobbie. ***Evolution and Validation of a Personal Form of an Instrument for Assessing Science Laboratory Classroom Environments.*** **Located in: Journal of Research in Science Teaching 32, April 1995, pp. 399-422.**

The *Science Laboratory Environment Inventory* (SLEI) was developed to elicit: (1) students' perceptions of the class as a whole, and (2) each student's perception of his or her own role within the classroom. The SLEI has 35 questions organized into five subscales: Student Cohesiveness (the extent to which laboratory activities emphasize an open-ended, divergent approach to experimentation), Integration (the extent to which laboratory activities are integrated with non-laboratory and theory classes), Rule Clarity (the extent to which behavior in the laboratory is guided by formal rules), and Material Environment (the extent to which laboratory equipment and materials are adequate). Each question, such as "My laboratory class is rather informal and few rules are imposed on me," is answered on a five-point scale, from "almost never" to "very often." The paper includes a good deal of technical information; the instrument was field-tested with 5,447 students in 269 high schools and university classes in six countries.

(AL# 600.3EVOVAP)

Gayford, Christopher. ***Group problem solving in biology and the environment*****, 1989-93. Available from: Department of Science and Technology, University of Reading, Reading, Berkshire RG6 1HY, England, UK, (073) 431-8867.**

This document consists of three journal articles: *A Contribution to a Methodology for Teaching and Assessment of Group Problem Solving in Biology Among 15-Year Old Pupils.* Located in Journal of Biological Education 23, 1989, pp. 193-198. *Patterns of Group Behavior in Open-Ended Problem Solving in Science Classes of 15-Year-Old Students in England.* Located in: International Journal of Science Education 14, 1992, pp. 41-49. *Discussion-Based Group Work Related to Environmental Issues in Science Classes with 15 Year-Old Pupils in England.* Located in: International Journal of Science Education 15, 1993, pp. 521 -529.

The author reports on a series of related studies in which secondary students engaging in group work are assessed on a variety of skills such as group process, problem solving, attitudes, and science process. The purposes of the studies were to: (1) explore the use of group discussion as a way to develop and exercise skills such as communication, problem solving, and numeracy; (2) discover how students approach problem solving tasks; and (3) describe the group dynamics of students engaging in group problem solving tasks. The papers are included here because of the assessment devices developed by the author to examine student problem solving and process skills.

The specific tasks in which students were engaged in these studies were discussions of controversial issues about the environment and practical investigations in which students were to determine the best source of a substance or the amount of water needed by various plants. Students worked in groups. Each task took from 60-90 minutes. Performance was assessed using a variety of scoring guides, the most detailed of which was a generalized rubric assessing ability to state the problem, ability to work cooperatively as a team, quality of reasons for choice of design, ability to modify the design as a result of experience, and ability to evaluate success. Performance was rated on a three-point scale.

The papers include a good enough description of the tasks and scoring procedures that they could be reproduced by the reader. The paper also includes information about student performance on the tasks. No other technical information nor sample student responses are included. Permission to reproduce materials has been granted by the author.

(AL# 600.3CONTOM)

Germann, Paul J. ***Development of the Attitude Toward Science in School Assessment and Its Use to Investigate the Relationship Between Science Achievement and Attitude Toward Science in School.*** **Located in: Journal of Research in Science Teaching 25, 1988, pp. 689-703.**

The *Attitude Toward Science in School Assessment (ATSSA)* survey was based on a theoretical model which not only attempts to distinguish between different aspects of "attitude" but also additional factors that affect behavior. The ATSSA has 14 statements such as, "Science is fun"; students indicate their degree of agreement with the statement. The paper presents the results of several studies using the instrument with students in grades 7-10. As a result of the studies, the author concludes that, "The ATSSA is a valid and reliable instrument that can be useful in sorting out the relationships between variables that affect achievement and attitude. School departments, science departments, and classroom teachers can use this assessment to monitor general attitude toward science in school among the students in their instructional programs. " The entire instrument is included in the article.

(AL# 210.3DEVATT)

Gong, Brian, Richard Venezky, and David Mioduser. ***Instructional Assessments: Lever for Systemic Change in Science Education Classrooms.*** **Located in: Journal of Science Education and Technology 1, 1992, pp. 157-176.**

This article describes how the Educational Testing Service/University of Delaware Science Education project addressed systemic change in science education through the use of assessment. The first part of the paper argues that instructional assessment is classroom-based, educational, self-administered, and empowers learners and teachers.

The second part of the article focuses on how to design such instructional assessments in grades 4-8, and the effects of such instructional assessment materials and practices on science education. Project teachers developed sample instructional units dealing with science themes, explanatory principles, and causal models within the context of water resources, tools and technology, meteorology, and control systems. Each unit is problem-centered, and the units cross science disciplines and non-science areas such as art, mathematics, language arts, and social studies. Two descriptions of sample units—tools and technology and water resources—are presented. Unfortunately, the article does not include actual assessment materials or scoring rubrics.

The final section of the article deals with staff development as a key to systemic change. The authors claim that instructional assessment has changed staff assessment focus from grading to content-based analyses.

(AL# 600.6INSASL)

Green, Barbara. ***Developing Performance-Based Assessments and Scoring Rubrics for Science,*** **1993. Available from: Texas Education Agency, Instructional Outcomes Assessment, 1701 N. Congress Ave., Austin, TX 78701, (512) 463-9734.**

This document consists of two grade 4 and 8 science process skills assessment tasks—design an insulating container for ice cubes (grade 4) and determine the absorbency of paper towels (grade 8). These illustrate the two basic kinds of tasks developed in Texas—design and inquiry. Students plan and carry out their designs or inquiries at stations having a standard set of disposable and nondisposable materials. Students respond in writing (showing pictures, diagrams, and data displays when appropriate) to printed directions. For example, the grade 4 task asks students to plan the design (draw a picture and write a description), construct the design and test it, improve the design, and write a report (written analysis and conclusion).

Scoring uses a different holistic four-point scale for each of the two types of tasks—designs and investigations. For example, a "4" on design tasks means:

> The overall response is consistent with a sound scientific approach to design. The response indicates that the student has a clear understanding of the problem. The response may, in some cases, define additional aspects of the problem or include extensions beyond the requirements of the task. Some inconsistencies may be present, but they are overwhelmed by the superior quality of the response. A score point '4' response is characterized by most of the following....

The package of materials we received has descriptions of the two tasks, a sample student response for each (unscored), and the scoring guide for each. No technical information is included. The contact person has given permission for educators to reproduce, for their own students, the materials submitted.

(AL# 600.3PERBAA)

Greig, Jeffrey, Naomi Wise, and Michal Lomask. ***The Development of an Assessment of Scientific Experimentation Proficiency for Connecticut's Statewide Testing Program,*** **1994. Available from: Connecticut State Department of Education, 165 Capitol Ave., Hartford, CT 06106, (203) 566-5677.**

In the Connecticut Academic Performance Test (CAPT) design, students are given a hands-on laboratory activity during a four-week period prior to the administration of the written portion of the test. The task presents students with a real-world problem. Students work in pairs to define a specific research question, design and carry out experiments to solve the problem, and draw conclusions based on their results. An example of a CAPT science performance task is included. Students then work individually to write about their experiments and results in the form of a written lab report. These lab reports are not collected and scored at the state level. Rather, teachers are encouraged to score their own students' work and provide them with feedback.

During the written portion of the test, students are given follow-up questions which relate directly to the performance task. These questions are designed to assess students' ability to apply their understanding of scientific experimentation by critiquing sample results. The questions provide students with hypothetical experimental designs, results, and conclusions from the performance task and ask them open-ended questions about the quality of the work shown. Examples of the follow-up questions are included. The results of the follow-up questions are scored at the state level and used in combination with other items to formulate the students' experimentation score.

This paper also describes research that was conducted during the development of the CAPT science assessment to answer such questions as:

- Does completing the performance task affect students' scores on the follow-up questions?
- Does the amount of time between completing the performance task and the written test affect students' scores on the follow-up questions?
- What is the relationship between students' scores on their lab reports and on the follow-up questions?
- What is the relationship between students' prior experience in performing labs in their science classes and their scores on the follow-up questions?
- To what degree are the performance tasks comparable?

(AL# 600.3DEVASS)

Hall, Greg. *Performance Assessment in Science—STS Connections,* 1993. Available from: Alberta Education, Box 43, 11160 Jasper Ave., Edmonton, AB T5K 0L2, Canada, (403) 427-0010, fax (403) 422-4200.

The 1993 "Grade 9 Science Performance-Based Assessment" consists of six stations set up in a circuit at which students perform a variety of investigations: seed dispersal, calibrating a hydrometer and using it to measure the density of a sugar solution, determining which of several choices is the best insulator, building a robot arm, testing for contaminates, and examining an environmental issue. Three circuits, accommodating a total of 15 students, is recommended. Each group requires two hours. Students respond in writing to a series of questions.

Responses for the Grade 9 assessment were scored on two dimensions: problem solving/inquiry skills and communication. The scoring guide is generalized (the same one is used across all tasks) and uses a four-point (0-3) scale. A "3" for Inquiry is: "Analyzed and readily understood the task, developed an efficient and workable strategy, strategy implemented effectively, strategy supports a qualified solution, and appropriate application of critical knowledge." A "3" for Communication is: "Appropriate, organized, and effective system for display of information or data; display of information or data is precise, accurate, and complete; and interpretations and explanations logical and communicated effectively."

The documents we have contain: a general overview of the procedures, complete activity descriptions, an administration script and the scoring guide. Student booklets for the 9th grade assessment, technical information and sample student responses are not included. Rubrics are somewhat skimpy.

(AL# 600.3PERAST)

Hall, Greg. *Science Performance Assessment and Standards: Just Do It!, 1994.* **Available from: Greg Hall, 16 Ainsley Pl., St. Albert, Alberta, Canada T8N 5V8.**

This document is the 1994 version of Alberta Education's grade 6 and 9 science performance assessment intended to assess science inquiry, technological problem solving, and decision-making skills. Students complete six hands-on tasks set up in a circuit. The document includes a description of how to set-up the circuit; the materials needed for each station; and a two-trait, general scoring guide. No sample student responses or technical information are included. (Note: The grade 9 assessment is the same as that in 1993—see Hall, 600.3PERAST; but the material from grade 6 is different.)

(AL# 600.3JUSDOI)

Halpern, Diane (Ed.). ***Enhancing Thinking Skills in the Sciences and Mathematics,*** **1992. Available from: Lawrence Erlbaum Associates, Publishers, 365 Broadway, Hillsdale, NJ 07642, (800) 926-6579.**

This book is not strictly about assessment. Rather, it discusses the related topics of "What should we teach students to do?" and "How do we do it?" The seven authors "criticize the conventional approach to teaching science and math, which emphasizes the transmission of factual information and rote procedures applied to inappropriate problems, allows little opportunity for students to engage in scientific or mathematical thinking, and produces inert knowledge and thinking skills limited to a narrow range of academic problems. " (p. 118). In general, they recommend that teachers focus on the knowledge structures that students should know, use real tasks, and set up instruction that requires active intellectual engagement. The authors give various suggestions on how to bring this about: instructional methods, videodiscs, group work, and a host more.

(AL# 500.6ENHTHS)

Harcourt Brace. ***Stanford Achievement Test—Ninth Edition*****, 1996. Available from: Order Fulfillment Dept., The Psychological Corporation, P.O. Box 839954, San Antonio, TX 78283, (800) 228-0752, fax (800) 232-1223.**

The open-ended portion of the SAT-9 covers reading, math, science, social studies, and writing. It can be used alone or in conjunction with the multiple-choice portion. For reading, math, science, and social studies, there are 11 levels (2 forms each level) spanning grades 1.5-13. Writing has 9 levels (2 forms) across grades 3.5-13. All forms have 9 open-ended questions, some around a theme (for example, the theme of Primary 3, Math is the zoo) and some not. Writing provides prompts for 4 types of writing: descriptive, narrative, expository, and persuasive. Scoring guides were not included in the materials we received.

Norms are available. The documents we have include a sampling of the Stanford 9 open-ended assessments—various grade levels in reading, science, math, and/or writing.

(AL# 060.3STAACT9)

Hardy, Roy. ***Options for Scoring Performance Assessment Tasks,*** **1992. Available from: Educational Testing Service, 1979 Lakeside Parkway, Suite 400, Tucker, GA 30084**

Four assessment tasks were developed to explore the feasibility of performance assessment as part of a statewide assessment program. Tasks were: shades of color (grades 1-2), discovering shadows (grades 3-4), identifying minerals (grades 5-6), and designing a carton (grades 7-8). The tasks are described in the paper, but all of the relevant materials are not included. Each task was designed to take one hour. Most tasks are completed individually, but one (cartons) is a group task.

Response modes varied (multiple-choice, figural, short narratives, products), in part to see which are feasible, and in part to see how different kinds of scores relate to each other. Most scoring was right/wrong or holistic on degree of "correctness" of answer. Cartons was scored holistically on problem solving. The scoring procedures are not presented in detail. The paper also describes the process used to develop scoring rubrics, train scorers, and analyze the data. No sample student responses are included in this document.

The tasks were completed by 1,128 students from 66 classes in 10 school districts. Teachers completed a survey (questions are included in the paper). Results showed that it took from 1/2 to three minutes to score the performances, interrater agreement ranged from 76 to the high 90's, relationships between scoring procedures varied, and teachers liked the procedures. In all, the author concluded that it is feasible to use performance tasks in statewide assessment.

(AL# 600.3OPTSCP)

Hein, George E. and Sabra Price. ***Active Assessment for Active Science—A Guide for Elementary School Teachers,*** **1994. Available from: Heinemann, 361 Hanover St., Portsmouth, NH 03801.**

This short book provides a somewhat cursory overview of:

- rationale for changes in assessment
- types of assessment
- managing assessment
- performance assessment
- grading

The book does a reasonable job discussing performance criteria for assessing general science process skills and managing assessments in the classroom. The target audience is teachers of students in grades 1-6.

(AL# 600.6ACTASA)

Hibbard, K. Michael. ***What's Happening?*****, 1991. Available from: Region 15 School District, PO Box 395, Middlebury, CT 06762, (203) 758-8250.**

This document is a series of performance tasks in which assessment is integrated with instruction. The tasks include chemical reaction, consumer action research, plant growth, physiological responses of the human body, survival in the winter, science fiction movie development, and food webs. Each task includes assessment rating forms and checklists, some of which are designed for student self-assessment. For example, the *survival in winter* exercise includes a rating scale that assesses 12 features of the project on a scale of 1-5, and a rating scale for an oral presentation. Other tasks include performance criteria for group work and self-rating on perseverance. The performance criteria are a mixed bag Some directly refer to specific features of the task (e g., "detailed descriptions were given of each plants' growth"). Others are general features that could be applied to many tasks (e g., "shows persistence"). However, there is no standard set of criteria across tasks; there is a different number of criteria and a different mix of specific and general criteria depending on task.

The assessments were developed for classroom use and do not include detailed definitions of traits to be rated, nor sample anchor performances. This is just a set of tasks with no explanatory text. No technical information is included.

(AL# 600.3WHAHAP)

Holley, Charles D. and Donald F. Dansereau. ***The Development of Spatial Learning Strategies (Chapter 1)*****, pp. 3-15. Surber, John R.** ***Mapping as a Testing and Diagnostic Device (Chapter 10)*****, pp. 213-233. Located in: Charles D. Holley and Donald F. Dansereau, Eds.,** ***Spatial Learning Strategies—Techniques, Applications, and Related Issues*****, 1984. Available from: Academic Press, 525 B St., Suite 1900, San Diego, CA 92101, (619) 231-6616, Internet: www.academicpress.com**

This somewhat technical and formal paper describes the use of cognitive maps to assess student comprehension of concepts. Technical information is included.

(AL# 150.6SPALES)

Illinois Science Teachers Association. ***Science Performance Assessment Handbook—Draft,*** **1993. Available from: Illinois State Board of Education, 100 N. First St., Springfield, IL 62777, (217) 782-4321, fax (217) 782-0679.**

This handbook "is designed to provide assistance to the instructor who is attempting to develop performance assessments along with the procedures for administering them. " It contains a very brief textual section that covers definitions and basic assessment concepts. This description might be too brief or complex for some readers. The bulk of the document is made up of sample assessments which include complete administration instructions but no technical information. All scoring is task specific, except where noted.

- *Hands On Tests for Science* (primary grades). Students complete simple hands-on activities at five stations—classification of objects, measurement, making observations, drawing inferences, and making predictions (10 minutes per station).

- *A Science Investigation* (grades 3-5). Students collect information, make a graph, make predictions from their data, and write-up what they did (1 hour).

- *Relative Humidity* (group project, grade 7). Groups choose one of six investigations and are given two weeks to plan, carry out, and write up the results. Students are scored on lab work written report, cooperation, and oral presentation. The scoring guide is general but sketchy.

- Design an experiment to test a hypothesis (middle school). Scoring focuses on quality of explanation, but guidelines are sketchy.

- Mirror image construction (middle school).

- Densities of liquids and solids (high school). Responses are scored using a general rubric along three dimensions: experimental design, observations and calculations, and conclusions.

- Battery and bulbs (portfolio, middle school). Some content is specified by the technical information; students get to choose some content. No criteria are provided.

(AL# 600.3SCIPAH)

Johnson, David W., and Roger T. Johnson. ***Group Assessment as an Aid to Science Instruction,*** **1990. Located in: Champagne, Lovitts and Calinger (Eds.), Assessment in the Service of Instruction, 1990, pp. 267-282. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643]. Also located in: G. Kulm & S. Malcom (Eds.), Science Assessment in the Service of Reform, 1991, pp. 103-126, AAAS.**

The authors favor cooperative learning in science because of research that shows positive effects on student learning and attitudes. Group assessment involves having students complete a lesson, project, or test in small groups while a teacher measures their level of performance on reasoning processes, problem solving, metacognitive thinking, and group interactions. The authors also maintain that this procedure increases the learning it is designed to measure, promotes positive attitudes toward science, parallels instruction, and reinforces the value of cooperation. The article describes how to structure performance tasks in a cooperative framework. The authors then describe, in general, different ways to record the information from the task—observational records, interviews, individual and group tests, etc. This is only a general overview of the possibilities and provides no specific rubrics, forms, or questions.

(AL# 600.6GROASA)

Jones, M. Gail. ***Performance-based Assessment in Middle School Science.*** **Located in: Middle School Journal 25, March 1994, pp. 35-38.**

The author presents some ideas on how to do performance-based classroom assessments of science process skills. She recommends reviewing units of study to analyze the process skills being emphasized, identifying the observable aspects of each skill, and designing tasks that allow you to observe the skills. The author illustrates this process in various ways—both by giving an extended example on coastal ecology, and by listing science process skills, some observable behaviors, and related examples of tasks students could be given to elicit the behavior. The discussion of how to score responses is not as complete. No technical information is provided.

(AL# 600.6PERBAS)

Jungwirth, Ehud, and Amos Dreyfus. ***Analysis of Scientific Passages Test,*** **1988. Available from: Educational Testing Service, Tests in Microfiche, TC922019, Set R. Also referenced in: "Science Teachers' Spontaneous, Latent or Non-attendance to the Validity of Conclusions in Reported Situations," Research in Science and Technological Education 8, 1990, pp. 103-115.**

The authors have developed a measure of science teacher critical thinking. Teachers are asked to identify the similarities between two passages in which the same invalid conclusion is reached. Passages illustrate "post hoc" thinking; attributing causality to an antecedent event; drawing conclusions about a population from a non-representative sample; and acceptance of tautologies as explanations. Teachers respond in writing. There are four forms. No technical information, except performance of one group of 76 teachers, is available.

(AL# 600.4ANASCP)

Kanis, I. B. ***Ninth Grade Lab Skills.*** **Located in: The Science Teacher, January 1991, pp. 29-33.**

This paper provides a summary description of the six performance tasks given to ninth grade students as part of the 1985-86 Second International Science Study to assess laboratory skills. A brief description, a picture of the lab layout, and a list of scoring dimensions are provided for each task. It appears that scoring is essentially right/wrong and task-specific. Students were scored on ability to manipulate material, collect information, and interpret results. A brief discussion of some results of the assessment are provided. There is enough information here to try out the tasks, but not enough to use the performance criteria. No sample student performances are included. The paper also discusses problems with many current lab activities (too cookbook) and how to redesign lab exercises to promote higher-order thinking skills.

(AL# 600.3NINGRL)

Kentucky Department of Education. ***Kentucky Instructional Results Information System (KIRIS),*** **1993-94. Available from: Kentucky Department of Education, Division of Accountability, 1900 Capital Plaza Tower, 500 Mero St., Frankfort, KY 40601, (502) 564-4394.**

The Kentucky Instructional Results Information System is an assessment program that monitors grades 4, 8, and 12 student achievement in reading, social studies, science, and mathematics. The assessment has three parts: multiple choice/short essay, performance assessment, and portfolios. Assessment results place students in one of four performance levels: novice, apprentice, proficient, or distinguished. The document we received contains grade 4, 8, and 12 performance assessment items in reading, social studies, science, and mathematics. All items are paper and pencil. Task-specific scoring guides are included.

(AL# 060.3KIRIS94)

Kentucky Department of Education. ***Performance Events, 1992-93, Grade 8.*** **Available from: Kentucky Department of Education, Capital Plaza Tower, 500 Mero St., Frankfort, KY 40601, (502) 564-4394.**

This document includes three performance tasks and related scoring guides from the 1993 grade 8 assessment. The tasks relate to mapping the ocean floor, identifying bones, and water pollution. There is both group and individual work using a variety of manipulatives. Each task consists of a series of related questions, some of which have only one right answer and some of which are more open-ended. Scoring employs task-specific scoring guides developed from a generic guide that covers completion of the task, understanding, efficiency/ sophistication, and insight. Scored student responses are included. No technical information is included.

(AL# 600.3PEREVG)

Kessler, Rohn, Leslie A. Ditson, Lynne Anderson-Inman, et al. *Evaluating Concept Maps in Traditional and Electronic Environments: Inter-Rater Reliability and Beyond* (DRAFT Version), undated. Available from: Author, University of Oregon, CES, 1244 Walnut, Eugene, OR 97403, (541) 346-3111.

The author presents an up-to-date view of the use of concept maps as instructional and assessment tools. His two specific examples relate to community college student maps of "insects" and 7th grade student maps of "the universe." The authors also explore the usefulness of "scoring" these concept maps in various ways. Technical information is included.

(AL# 000.3EVACOM)

Khattri, Nidhi. *Performance Assessments: Observed Impacts on Teaching and Learning*, 1995. Available from: Pelavin Associates, 2030 M St. NW, No. 800, Washington, DC 20036, (202) 785-3308, fax: (202) 785-0664.

The author attempted to document the impact of performance assessment on teaching and learning. The author visited 14 schools in fall 1994 and spring 1995 to examine student work; observe in classrooms; and interview school personnel, students, and parents.

The authors report the following findings: "(1) students are being asked to write, to do project-based assignments, and to engage in group learning due to the use of performance assessments; and (2) as a result of project-based assignments, students are more motivated to learn. Furthermore, because of the use of performance-based assignments and the degree of freedom accorded to students in shaping their own work...collaboration is evident. Increasingly, teachers are viewing students as active learners. "

All of the effects depended on: (a) the form of the assessment (e.g., portfolio or performance event); (b) the degree of integration of the assessment into the classroom; and (c) the level of support provided to incorporate the assessment into routine classroom activities. The positive effects on teaching are most evident for sites using portfolio assessments, mostly because the portfolio format provides teachers and students control over products coupled with a structure for documenting student work and student progress on an ongoing basis.

(AL# 150.6PERASO)

Kind, Per Morten. ***Exploring Performance Assessment in Science,*** **March 1996. Doctoral dissertation submitted to the University of Oslo.**

This dissertation is not an easy read but is thought-provoking. (Read the conclusion section first.) The author takes issue with the theoretical model of the nature of science process skills that underpins the Third International Mathematics and Science Study (TIMSS). He seems to find TIMSS too heavily based on general cognitive skills such as "classifying," "hypothesizing," and "interpreting." He wants more emphasis on deep conceptual understanding. He also felt that tasks were too heavily scaffolded to really see if students understood what they were doing. He proposes an alternative approach and illustrates it with work done in Norway.

(AL# 600.6EXPPEA)

Kleinsasser, Audrey, Elizabeth Horsch, and Denise Wheeler. ***Teacher-Researchers Investigating Science and Math Performance Assessments: Expanding Traditional Roles,*** **1995. Available from: Audrey Kleinsasser, Box 3374, College of Education, University of Wyoming, Laramie, WY 82071.**

The authors describe four teacher-researcher projects on the impact of the use of classroom-based performance assessments. The authors conclude that there is value in student-directed learning and assessment, and teacher-student assessment collaboration.

(AL# 600.6TEAREI)

Koballa, T.R. ***Goals of Science Education,*** **1989. Located in: D. Holdzkom and P. Lutz (Eds.), Research Within Reach: Science Education, pp. 25-40. Available from: National Science Teachers Association, Special Publications Department, 1742 Connecticut Ave. NW, Washington, DC 20009, (202) 328-5800.**

Assessment should be designed to cover important student processes and outcomes. This article is included because it discusses what our goals for students should be. Specifically, the author maintains that most science curricula are oriented toward those students that want to pursue science academically and professionally. We should also, however, be looking at science education as a means of promoting other important goals for students such as: wanting to know and understand, respect for logic, and capacity to cope with change.

(AL# 600.5GOASCE)

Kober, Nancy. ***What We Know About Science Teaching and Learning,*** **1993. Available from: Council for Educational Development and Research (CEDaR), 2000 L Street, NW, Suite 601, Washington DC 20036, (202) 223-1593.**

This booklet provides a very nice summary and overview of the changes in science instruction and assessment and the reasons for the changes. It includes short sections on such topics as: why science is important for all citizens, why science instruction needs to change, instructional ideas, implications for policy, curriculum standards, how to send the message that science is important, equity issues, instructional methods, staff development needs of teachers, and the role of parents and the community.

(AL# 600.6WHAKNS)

Kulm, Gerald, Shirley M. Malcom. ***Science Assessment in the Service of Reform,*** **1991. Available from: American Association for the Advancement of Science, 1333 H St. NW, Washington, DC 20005 [AAAS Books: (301) 645-5643].**

This book contains articles from various authors who discuss: current issues surrounding science assessment, the rationale for considering alternatives, curriculum issues and trends, and alternative assessment initiatives in various states and countries. (The latter is somewhat out-of-date.) The individual articles that appeared to be of most interest to users of this bibliography are entered separately.

(AL# 600.6SCIASI)

Lawrence, Barbara. ***Utah Core Curriculum Performance Assessment Program: Science,*** **1993. Available from: Profiles Corporation, 507 Highland Ave., Iowa City, IA 52240.**

The Utah State Office of Education has developed 90 short-answer items in mathematics, science and social studies (five in each of grades 1-6 for each subject) to complement multiple-choice tests already in place. Assessments are designed to match the Utah Core Curriculum. Although districts must assess student status with respect to core-curriculum goals, use of the state-developed assessments is optional.

The science assessments are designed to measure four general process skills: identify/describe, explain, infer, organize, and create. Each task has several questions relating to a common theme. Most student responses are short (some are multiple-choice); the longest are no more than a paragraph. Scoring is task-specific and based either on getting the correct answer (0-3 points) or quality of the response (0-2 points). Points are totaled across tasks for each of the four process skills. Four levels of proficiency on each skill are identified: advanced, proficient, basic, and below basic based on percent correct and behavioral descriptions of performance at each level.

The Office of Education has collected information on teacher reaction to the assessments. No other technical information is available. An introductory training video is available which helps teachers use the assessment program (but does not deal specifically with science.)

(AL# 600.3UTACOC and 000.6INTUTCv—video)

Lawrence Hall of Science. *Full Option Science System—Water Module,* 1992. Available from: Encyclopedia Britannica Educational Corporation, 310 S. Michigan Ave., Chicago, IL 60604, (800) 554-9862. Also available from: Lawrence Hall of Science, University of California, Berkeley, CA 94720, (510) 642-8941.

The *Full Option Science System is* a series of hands-on instructional modules with associated assessments. The module reported here is on water. There are three parts to the assessment, all of which are described in detail in the document. The first part is a series of hands-on activities set up in stations. Examples are: "Put three drops of mystery liquid on wax paper and observe what happens." and "What do your observations tell you about the mystery liquids?" The second part of the assessment is a short-answer paper-and-pencil test that takes about 15 minutes. The third part of the assessment is an application of concepts in paper and pencil format that takes about 20 minutes. All answers are scored for degree of correctness. Administration and scoring information is provided, but no technical information on the tests nor information about typical performance is given.

(AL# 600.3FOSSWM)

Lazear, David. *Multiple Intelligence Approaches to Assessment—Solving the Assessment Conundrum*, 1994. Available from: Zephyr Press, PO Box 66006-W, Tucson, AZ 85728, (602) 322-5090, fax: (602) 323-9402.

This manual discusses:

- Definitions and importance of seven student "intelligences."
- How to "kid watch" to determine which intelligences each student has strengths in.
- Ideas for using the "intelligences" profile to help kids get the most out of instruction.
- Ideas for developing students' weaker "intelligences."
- Criteria for sound assessment that include attention to both (a) assessing the seven intelligences, and (b) designing a variety of achievement measures that are couched in the terms of the seven intelligences.
- Lots of help on designing assessments in various content areas that capitalize on strengths in the various intelligences and allow students to show what they know in a variety of ways.

- The use of portfolios, journals, anecdotal records, and exhibits on the context of the seven intelligences.

- Ideas for getting started.

- Sample reporting formats that emphasize both development in the seven intelligences and development in the skills and knowledge through the seven intelligences.

I like the detail, specific examples, and easy readability of this one. There were lots of good ideas. Some readers might be put off by the seeming emphasis that developing the seven intelligences should be the *goal* of instruction rather than just the *means* of instruction and assessment. However, there is much here for either use.

(AL# 000.6MULINA)

Lee, Elaine P. *Discovering the Problem of Solid Waste: Performance Assessments,* 1991. Available from: Lake County Educational Service Center, 19525 W. Washington St., Grayslake, IL 60030, (708) 223-3400.

In this booklet, 17 performance tasks on solid waste are presented for students in grades 3-6. Each performance task contains information about grade level, concepts being assessed (e.g., types of solid waste or recognizing changes in materials in a landfill), process skills needed to complete the task (e.g., classifying, measuring, observing, or ordering), and the objects/items needed for the task, directions, and questions to answer. Many of the tasks are completed at home or at a work station in the classroom. Scoring emphasizes the correctness of the response; the scoring guides are different for each task. The guide provides information on the maximum points to assign for each question and for the entire task. No information on staff training or technical information is provided.

(AL# 620.3DISPRS)

Liftig, Inez Fugate, Bob Liftig, and Karen Eaker. *Making Assessment Work: What Teachers Should Know Before They Try It.* Located in: Science Scope 15, March 1992, pp. 4-8.

The authors contend that students have trouble taking alternative assessments because they have no practice doing do. For example, they don't know the higher-order thinking skills vocabulary that is often used in performance tasks, so they don't know what to do. They also don't know what it takes to do well. The authors recommend that students learn vocabulary, practice oral and written communication, and are careful not to leave anything out because they figure that the teacher already knows the student knows it. A list of vocabulary is included.

(AL# 600.6MAKASW)

Lock, Roger. ***Gender and Practical Skill Performance in Science.*** **Located in: Journal of Research in Science Teaching 29, 1992, pp. 227-241.**

This paper is included because of its brief descriptions of the performance tasks used to assess practical skill. The four tasks were: measuring the rate of movement of blow fly larvae in dry and damp atmospheres, finding out how the size of the container with which a burning candle is covered affects the length of time for which the candle burns, determining the mass supported by a drinking straw, and identifying an unknown solution. Only one of these (straws) is described in enough detail to replicate. There are separate performance criteria for each task. Student performance is assessed live by listening to what the student says while he or she does the task, by watching what the student does, and by looking at what the student writes down. The criteria for the unknown solution task are given.

Because of the nature of the research reported, some technical information is included on the tasks. An attempt to obtain more information from the author was unsuccessful.

(AL# 600.6GENPRS)

Lokan, Jan, and Brian Doig. ***Performance Assessment, Australian Style or 'How Standard Can Standard Be?'*** **Paper prepared for the American Educational Research Association Annual Conference, New York, April 1996. Available from: Brian Doig, The Australian Council for Educational Research Ltd., 19 Prospect Hill Rd., Camberwell, Melbourne, Victoria 3124, Australia, phone 03-819-1400.**

This paper discusses Australia's experience in administering the TIMSS (Third International Mathematics & Science Study) performance assessment. The authors conclude that the TIMSS performance assessment components "pass muster" in logistics, costs, and issues although use for describing the achievement of individual students is problematic. The actual performance assessment tasks are not described.

(AL# 600.6PERASU)

Macdonald Educational. ***Learning Through Science,*** **1989. Available from: Macdonald Educational, Wolsey House, Wolsey Road, Hemel Hempstead HP2 4SS, England, UK. Also available from: Teachers' Laboratory, Inc., PO Box 6480, Brattleboro, VT 05301, (802) 254-3457.**

This is one of a series of publications developed to promote instructional reform in science in the United Kingdom. The reform movement emphasizes active learning and concept development. In addition to sections covering such topics as "why do science" and how to organize instruction, one chapter covers record keeping. This chapter proposes keeping track of student development toward mastery of broad scientific concepts and habits of thought rather than keeping track of activities completed. The chapter provides a brief description of a rating procedure (presented in more detail in another publication) for 24 attributes such as:

curiosity, perseverance, observing, problem solving, exploring, classifying, area, and time. A sample five-point rating scale for one of the attributes, curiosity, is given.

An appendix to the book also provides developmental continua for: attitudes, exploring observations, logical thinking, devising experiments, acquiring knowledge, communicating, appreciating relationships, and critical interpretation of findings. These could be adapted for use in keeping track of student progress in a developmental fashion.

(AL# 600.6LEATHS)

Macdonald Educational. *With Objectives in Mind,* 1984. Available from: Macdonald Educational, Wolsey House, Wolsey Road, Hemel Hempstead HP2 4SS, England, UK. Also available from: Teachers' Laboratory, Inc., PO Box 6480, Brattleboro, VT 05301, (802) 254-3457.

This is one of a series of publications developed to promote instructional reform in science in the United Kingdom. This instructional reform emphasizes active learning and concept development. This document covers such topics as the contribution of science to early education, objectives for children learning science, and how to use the various instructional units that have also been produced as part of this series. There is a good discussion of how student understanding in science develops, which includes many samples of student behavior as illustrations of the various stages. This discussion could be adapted to constructing developmental continua for tracking student progress to be used for performance assessment.

(AL# 600.6WITOBM)

Maine Department of Education. *Maine Educational Assessment* [various documents], 1992, 1993, and 1994. Available from: Project Coordinator, Maine Educational Assessment, Department of Education, State House Station #23, Augusta, ME 04333, (207) 287-5991.

Information for this entry came from several documents: (1) "Guide to the Maine Educational Assessment," 1992-93; (2) "1993-94 Supplement: Guide to the Maine Educational Assessment"; and (3) "Performance Level Guide, 1994-95, Elementary and Grade 8." The Maine Educational Assessment (MEA) has been in place since 1984. It assesses reading, writing, mathematics, science, social studies, health, and arts/humanities at grades 4, 8, and 11. Not all subjects are assessed in any given year. Students answer multiple-choice as well as more open-ended questions. On the science and math tests, all open-ended questions are paper and pencil-based (no hands-on activities) and all responses are in writing.

In science, assessments cover knowledge/comprehension and application of knowledge, scientific inquiry, and the three content areas of life science, earth/space science, and physical science. Student responses are scored on a five point (0-4) scale emphasizing completion of all important parts of the task, effective communication, indepth understanding of the relevant content and procedures, choice of more sophisticated procedures, and insightful interpretations of results. A general rubric is tailored to individual problems.

Included are the rationale for the approach that is taken, many examples of problems and sample student responses, and a nice discussion of how Maine set overall "performance levels" (distinguished, advances, basic, or novice) in 1994. No technical information is included. (200 p.p.)

(AL# 000.3GUIMAE)

Marshall, G. ***Evaluation of Student Progress,*** **1989. Located in: D. Holdzkom and P. Lutz (Eds.), Research Within Reach: Science Education, pp. 59-78. Available from: National Science Teachers Association, Special Publications Department, 1742 Connecticut Ave. NW, Washington, DC 20009, (202) 328-5800.**

This paper presents a general overview of assessment development targeted at classroom teachers. The author emphasizes the need to clearly define outcomes for students and then match the outcome to the proper assessment technique—multiple-choice, essay, projects, practical tests and lab reports. Examples of each item type (using science content) are provided.

(AL# 600.6EVASTP)

Martinello, Marian L. ***Martinello Open-ended Science Test (MOST),*** **1993. Available from: University of Texas at San Antonio, Division of Education, San Antonio, TX 78249, (210) 691-5403, fax: (210) 691-5848.**

This assessment is designed to be administered as a pretest and posttest of scientific observation, inference, and supporting evidence skills for children in grades 2-5. A child is given an unknown object to examine (e.g., a crinoid, sweet gum seedpod, oak gall) and is asked to respond to three specific questions: (1) What do you see? (2) What do you think it is? (3) Why do you think so? Responses can be oral or written. Responses are scored by assigning points for each reasonable observation made, inference made, or piece of supporting evidence given by the student. The document includes a description of the general procedure and scored examples of student responses to "oakgalls" and "seed pods." Technical information is available from the author. Also, samples of student written responses are available.

(AL# 600.3MAROPS)

Maryland Assessment Consortium. *Performance Assessment Tasks Elementary Level, Volume 6* and *Performance Assessment Tasks Middle School, Volume 7,* **1994-95. Available from: Jay McTighe, Maryland Assessment Consortium @Urbana High School, 3471 Campus Dr., Ijamsville, MD 21754, (301) 874-6039, fax (301) 874-6057.**

The Maryland Assessment Consortium has published two notebooks of sample performance tasks in language arts, science, social studies, and mathematics. Some tasks are integrated across these areas. *Volume 6* contains 13 elementary tasks and *Volume 7* contains 9 middle school tasks. Each task includes complete instructions, test booklets and scoring guide, extension activities, special education modifications, and references. Tasks can include several activities related to a theme, group work, hands-on activities, reading and interpreting materials, and writing. Performance criteria tend to be task-specific with separate criteria for each part of the task. All tasks have been pilot tested. No technical information nor sample student work are included. This document includes one sample elementary task and one sample middle school task. Full sets are available from the author.

(AL# 000.3PERAST)

Maryland State Department of Education. *MSPAP (Maryland School Performance Assessment Program) Public Release Task—Oil Investigations, Grade 3, Science; Salinity, Grade 5, Science Language Usage*; **and** *Planetary Patterns, Grade 8, Science Language Usage*, **1994. Available from: Gail Lynn Goldberg, Maryland Department of Education, Maryland School Performance Assessment Program, 200 W. Baltimore St., Baltimore, MD 21201, (401) 333-2000.**

This document contains sample tasks for the 1994 Maryland hands-on science assessment for grades 3, 5, and 8. There is one task for each grade. Materials include the student response booklets, materials needed for the task, teacher administration instructions, and scoring guides (complete with sample student responses). Tasks involve both individual and group work, consist of several activities related to a theme (such as soil investigation or salinity), hands-on tasks, and written responses. Each part of each task is scored separately with a task-specific scoring guide. In grades 5 and 8 some student responses are also scored for language usage using a generalized scoring guide. No technical information is included.

(AL# 600.3MSPAPS)

Massell, Diane, and Michael Kirst, Eds. *Setting National Content Standards.* **Education and Urban Society 26, February 1994.**

This entire journal is a series of articles on the content standards' setting process in several content areas with a summary of the issues and suggestions for approaches.

(AL# 000.5SETNAC)

Masters, Geoff, and Margaret Forster. ***Developmental Assessment—Assessment Resource Kit*, 1996. Available from: Australian Council for Educational Research, 19 Prospect Hill Rd., Camberwell, Victoria, Australia, 3124, phone: +613 9277 5656, fax: +613 9277 5678**

This excellent publication clearly defines "developmental assessment" and systematically describes how to do it. Specifically, "developmental assessment is the process of monitoring a student's progress through an area of learning so that decisions can be made about the best ways to facilitate further learning. The unique feature of developmental assessment is its use of a progress map (or 'continuum'). A progress map describes the nature of development—or progress or growth—in an area of learning and so provides a frame of reference for monitoring individual development." The steps in "doing" developmental assessment are:

1. Construct a progress map (developmental continuum)

2. Collect evidence

3. Use the evidence to draw a conclusion about student development

Many examples are provided. No technical information is included.

(AL# 000.6DEVASA)

McColskey, Wendy, and Rita O'Sullivan. ***How to Assess Student Performance in Science: Going Beyond Multiple-Choice Tests—A Resource Manual for Teachers*, Revised June 1995. Available from: SouthEastern Regional Vision for Education (SERVE), 1203 Governors Square Blvd., Suite 400, Tallahassee, FL 32301, (800) 302-6001.**

This easily approachable booklet addresses two questions: (1) what is worth assessing in science, and (2) how best do we assess these things? There are lots of nice open-ended tasks designed to assess things like science process skills and conceptual understanding. There are also some nice activities to engage teachers in thinking about these issues. The samples of scoring guides (rubrics) tend to be a little skimpy (although there is a good discussion of rubric types). The discussion of portfolios and grading was a little too brief. All in all, this could be a useful introduction to science assessment if sections were carefully selected.

(AL# 600.6HOWASS2)

McDonald, Joseph P., Sidney Smith, Dorothy Turner, et al. ***Graduation by Exhibition—Assessing Genuine Achievement,* 1993. Available from: Association for Supervision and Curriculum Development, 1250 N. Pitt St., Alexandria, VA 22314, (703) 549-9110, fax (703) 549-3891.**

This book describes a strategy for school reform called "planning backwards from exhibitions. " In this approach, schools define a vision of what they want for graduates by proposing a task they want graduates to do well. Having set the vision, they have students perform the task and compare the vision against actual performance. Then they plan backwards what students would need to know and be able to do at various grades or ages in order to be able to do well on the final task. This booklet describes this process with three case studies, each proposing a different task "platform" against which they gauge student success—writing a position paper, inquiring and presenting, and participating in discussion seminars.

(AL# 150.6GRAEXA)

McTighe, Jay. *Developing Performance Assessment Tasks: A Resource Guide,* October 1994. Available from: Maryland Assessment Consortium, c/o Frederick County Public Schools, 115 E. Church St., Frederick, MD 21701, (301) 694-1337.

This is a notebook of performance assessment "must reads." The authors have assembled their favorite papers on: definitions, overview of performance assessment, and designing performance tasks and criteria. The notebook also contains Maryland's learner outcomes.

(AL# 150.6DEVPEA)

Meng, Elizabeth and Rodney L. Doran. *Improving Instruction and Learning Through Evaluation—Elementary School Science,* May 1993. Available from: ERIC, Clearinghouse for Science, Mathematics and Environmental Education, The Ohio State University, 1929 Kenny Rd., Columbus, OH 43210, (800) 443-ERIC.

This book contains a wealth of information about, and sample assessment tasks for, assessing student knowledge and skills in science. There is also a nice section on how to write all types of questions from true/false to "practical exams." Although there is much to like, there is some also to dislike. The author emphasizes task-specific scoring of performance tasks. And, the discussion of grading doesn't tackle the question of "why grade?" Finally, there is little discussion of student self-assessment and using assessment as a tool for learning. This would best be used by those knowledgeable in science assessment looking for ideas to fine-tune current practice.

(AL# 600.6IMPINL)

Mergendoller, J.R, V.A. Marchman, A.L. Mitman, et al. *Task Demands and Accountability in Middle-Grade Science Classes,* 1987. Located in: <u>Elementary School Journal</u> 88, pp. 251-265.

The authors maintain that the types of thinking students engage in and the quality of learning that occurs are largely influenced by the nature of the tasks students complete. After analyzing a large number of instructional and assessment tasks given to eighth graders, the authors conclude that, in general, the tasks given students present minimal cognitive demands. The article also provides suggestions about analyzing and modifying curriculum tasks.

Although not strictly about assessment, the article is included here to reinforce the notion that, as in instruction, the task given to students in a performance assessment can affect how well one can draw conclusions about student ability to think—if students are not given performance tasks that require thinking, it would be difficult to analyze responses for thinking ability.

(AL# 600.6TASDEA)

Moen, Vivian, and Paul Weill. ***Student Achievement Convention—1996-97; Guidelines for Grades K-12; Lane County, Eighth Annual.*** **Available from: Vivian Moen, Lane Education Service District, PO Box 2680, Eugene, OR 97402 (541) 461-8200, fax (541) 461-8298.**

The Lane County Student Achievement Convention (previously called "Project Fair") has expanded to have several components:

- The Project Fair itself, which "provides an opportunity for students to display a major learning experience that combines content knowledge with process skills to produce a product or demonstration of learning."
- The Portfolio Exhibition, which "provides students an opportunity to show others how their academic experiences are preparing them for life and future work."
- The Video Festival, for students entering video productions as projects.

Entries come from any grade or content discipline. The "Guidelines" document includes application materials, description of project, portfolio and video submissions, and criteria for judging submissions. Projects, for example, require a progress journal, in which "ideas, thoughts, observations, questions, resources, problems, impressions or discoveries encountered in the process of working on the project should be recorded day-by-day," an annotated resource list, a self-evaluation of the project, and an exhibit. Projects are judged in three areas: topic and treatment (3 scores); learning development and process (4 scores); and communication (3 scores). This is an excellent document. No technical information or samples of student work are included.

(AL# 000.3LANCOS)

National Academy of Sciences. ***National Science Education Standards*****, 1996. Available from: National Academy Press, 2101 Constitution Ave, NW, Box 285, Washington, DC 20055, (800) 624-6242 or (202) 334-3313. Internet: http://www.nas.edu**

This book includes standards for:

- Science teaching
- Professional development of science teachers
- Assessment in science
- Science content
- Science education programs, and
- Science education systems

It goes beyond lists by providing explorations and examples, especially for teaching science content and inquiry skills. The assessment section is a little skimpy in examples, although the standards and a list of the purposes for classroom assessment (only 1 of 5 relates to grading) are right on target.

(AL# 600.5NATSCE3)

National Center for Improving Science Education. ***Getting Started in Science: A Blueprint for Elementary School Science Education,*** **1989. Available from: National Center for Improving Science Education, 2000 L St. NW, Suite 602, Washington, DC 20036, (202) 467-0652. Also available from ERIC: ED 314 238.**

This report covers such topics as the rationale for science instruction, how children learn science, teacher development and support, and assessment. The chapter on assessment promotes the idea of assessment in the service of instruction—measuring the full range of knowledge and skills required for science, alignment with instruction, and a range of assessment approaches. The authors outline the characteristics of a good assessment system, including characteristics of tests, measuring affective as well as cognitive dimensions, and assessing instruction and curriculum.

(AL# 600.6GETSTS)

New Standards. *Performance Standards, Volume 1—Elementary School, Performance Standards, Volume 2—Middle School;* and *Performance Standards, Volume 3—High School*, 1997. **Available from: Harcourt Brace & Company, 555 Academic Ct., San Antonio, TX 78204, (800) 211-8378**

For the New Standards project, good quality standards should (a) establish high standards for all students, (b) be rigorous and world class, (c) be useful, developing what is needed for citizenship, employment, and life-long learning, (d) be important and focused, parsimonious while including those elements that represent the most important knowledge and skills within the discipline, (e) be manageable given the constraints of time, (f) be adaptable, permitting flexibility in implementation needed for local control, state and regional variation, and different individual interests and cultural traditions, (g) be clear and usable, (h) be reflective of broad consensus, resulting from an iterative process of comment, feedback, and revision including educators and the general public.

This document describes performance standards for English language, arts, mathematics, science, and "applied learning" (problem solving, communication, finding information, self-management, and working with others). The performance standards include descriptions of performance that is "good enough," samples of student work that illustrate the standards, and a commentary that describes *why* the work illustrates the performance standard. This work could be the basis for developing rubrics and for helping teachers and students understand characteristics of quality work.

(AL# 000.5NEWSTPe)(AL# 000.5NEWSTPm)(AL# 000.5NEWSTPh)

New York State Education Department. *Mathematics, Science and Technology Resource Guide*, **1997. Located at: http://www.nysed.gov/mst/ Information available from: The Mathematics, Science, and Technology Resource Guide, Room 681 EBA, New York State Education Department, Albany, NY 12234. (518) 474-5922.**

This document, taken from the Internet, has three parts:

1. Elements essential in planning a standards-based mathematics, science, and technology curriculum

2. Examples of learning activities that bring standards alive in the classroom

3. Assessments aligned with standards

The focus is on New York State standards and state-level assessment plans, but many of the ideas are more broadly applicable. For example, there is a nice part of the assessment section in which questions from the old Regents exams are rewritten to embody the new standards. The assessment section also includes pilot items from the new grade 4 and 8 state test, and

sample classroom assessments in grades 1, 8, and 10. Tasks are great; scoring mechanisms are a little skimpy.

(AL# 000.6MATSCT)

Noble, Audrey J. and Mary Lee Smith. ***Old and New Beliefs About Measurement-Driven Reform: "The More Things Change, the More They Stay the Same," CSE Technical Report 373*****, April 1994. Available from: National Center for Research on Evaluation, Standards and Student Testing (CRESST), Graduate School of Education, UCLA Graduate School of Education, 405 Hilgard Ave., 1320 Moore Hall, Los Angeles, CA 90024, (310) 206-1532.**

The authors analyze the reasons for the failure of Arizona's large-scale performance assessment innovations. They cite:

- While beliefs about instruction and assessment changed, the negative consequences traditionally associated with large-scale assessment did not
- Test administration was timed, students could not work collaboratively, and teachers could not act as mediators
- Limited attention was given to staff development

The authors conclude, "Its (Arizona Student Assessment Program's) focus on compliance and control in effect undermines its potential to create the context necessary for educators to develop the level of competence desired by those who hope to reform education."

(AL# 150.6OLDNEB)

Northwest Regional Educational Laboratory (NWREL). ***Assessment Strategies to Inform Science and Mathematics Instruction—It's Just Good Teaching*****, June 1997. Available from: Document Reproduction, NWREL, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9498, fax: (503) 275-0458.**

This short booklet is at a very introductory level. It briefly discusses the rationale for opening up assessment and the need to integrate assessment and instruction in science. Then it presents a brief description of methods—concept maps, writing, performance assessment, portfolios, etc. It discusses ideas in general terms, not specifics, and discusses only tasks, not criteria for judging work. It has a good "resources" section, where users could get more information on a topic.

(AL# 600.6ASSSTI)

Office of Educational Research and Improvement (OERI). ***Improving Math and Science Assessment. Report on the Secretary's Third Conference on Mathematics and Science Education.*** **Available from: U.S. Government Printing Office, Superintendent of Documents, Mail Stop: SSOP, Washington, DC 20402.**

This 15-minute video and companion booklet covers highlights of the secretary's third "Conference on Mathematics and Science Education: Improving Math and Science Assessment" during which more than 550 educators, researchers, and policymakers addressed such questions as "Why must assessment change?" "What forms of math and science assessments can help American students succeed in these subjects?" "How can districts reforming assessment assure that tests are fair for students of all races and income levels and both genders?" "How can better assessments fuel the drive toward comprehensive reform of American education and higher academic standards?" Recommendations, insights and information from the conference are incorporated into the video and the accompanying report. This annual event is sponsored by the US Department of Education.

(AL# 000.6IMPMASt—text and 000.6IMPMASv—video)

O'Malley, J. Michael and Lorraine Valdez Pierce. ***Authentic Assessment for English Language Learners—Practical Approaches for Teachers*****, 1996. Available from: Addison Wesley Longman, Jacob Way, Reading, MA 01867, (415) 854-0300, fax: (415) 853-2518, Internet: http://www.awl.com**

The authors look at ways to integrate assessment and instruction for English language learners (ELLs). The book is designed for classroom teachers in all grades. It does a nice job of presenting brief, but information-packed, presentations on the issues involved with assessing ELL students in ways that illuminate rather than mask what they know and can do; grading; portfolios; assessing language development; assessing reading; how to reduce the language demands of content-area assessments; targets to assess in the content areas—conceptual understanding, vocabulary, reading comprehension, thinking skills and the ability to construct written responses to questions, and how to assess these things—concept maps, cloze, and rubrics.

I rather liked this one—the philosophy was right and advice was good. I found most of their rubrics a little skimpy.

(AL# 350.6AUTASE)

O'Rafferty, Maureen Helen. ***A Descriptive Analysis of Grade 9 Pupils in the United States on Practical Science Tasks,*** **1991. Available from: University Microfilms International Dissertation Services, 300 N. Zeeb Rd., Ann Arbor, MI 48106, (800) 521-0600, microfilm #913 5126.**

This dissertation was a re-analysis of some of the information from the Second International Science Assessment (SISS), 1986, but it also includes a good description of the performance portion of the SISS and three of the six performance tasks. (The SISS also contained a multiple-choice portion and several surveys.) The three tasks included in this document were: determining the density of a sinker, chromatography observation and description, and identifying starch and sugar. Each task has a series of questions for the student to answer using the equipment provided. The questions ask students to observe, calculate, plan and carry out a simple experiment. Each question is classified as assessing one of three types of process skills: performing, reasoning, or investigating. One to two points were given for each answer. The basis for assigning points was not clear, but appears to be based on a judgment of the correctness of the response.

The dissertation includes a number of student responses to the tasks, overall performance of the US population, and several reinterpretations of the results. For example, student performance on questions classified as measuring the same skill were widely different. The author speculates that this is either because the definitions of the skills are imprecise, or because such unitary skills don't exist. The author also examined student responses for patterns of errors, and discussed the implications of this for instruction.

(AL# 600.3DESANP)

Oregon New Standards Project. ***Student Portfolio Handbook—Quantify/Science/ Mathematics—Field Trial Version/Elementary,*** **1994. Available from: Oregon Department of Education, Public Service Bldg., 255 Capitol St. NE, Salem, OR 97310, (503) 378-8004. Also available from: New Standards at the National Center on Education and the Economy, 39 State St., Suite 500, Rochester, NY 14614, (716) 546-7620, fax (716) 546-3145.**

This document describes the elementary science and mathematics portfolio developed by the Oregon New Standards Project. It is organized around the student goals for Oregon's Certificate of Initial Mastery (CIM)—content areas (number sense, estimation, geography, measurement, statistics; patterns; physical, earth, space and life systems); and process skills (science as inquiry, problem solving, interpreting results; connections; and communication). The document includes a description of these areas, examples of items that could be selected for the portfolio that demonstrate student ability in these areas, entry cover sheets, and a self-review checklist. Students are responsible for assembling their own portfolios. The document also includes draft scoring guides and a letter of introduction. No technical information or sample student work is included.

(AL# 000.3STUPOQ)

Ostlund, Karen L. *Science Process Skills—Assessing Hands-on Student Performance*, 1992. Available from: Addison-Wesley Publishing Co., 1 Jacob Way, Reading, MA 01867, (800) 447-2226.

This book contains activities at 6 levels (roughly grades 1-6 although no grade ranges are given) to assess 15 science process skills. There is one activity for each skill at each level. Instructions for scoring are not clear; "answers" are provided, but it is not clear whether responses are marked right/wrong, or how partial "correctness" is to be scored/handled. No technical information is included. The notion of dividing up the process skills and assessing each separately (without any rationale given) is also somewhat troubling. Thus, this booklet should only be used by knowledgeable persons who know what they are looking for and why they want it.

(AL# 600.3SCIPRS)

Ostlund, Karen L. ***Sizing Up Social Skills.*** **Located in: Science Scope 15, March 1992, pp. 31-33.**

The author presents a taxonomy of social skills important for the science classroom, provides a few ideas for how to teach them, and offers a couple of ideas on student and teacher monitoring techniques.

(AL# 223.6SIZUPS)

O'Sullivan, Christine. ***The Cost of Performance Assessment in Science: The NAEP Perspective,*** **1995. Available from: National Assessment of Educational Progress, PO Box 6710, Princeton, NJ 08541, (800) 223-0267, (609) 734-1918, fax: (609) 734-1878.**

The author analyzes the cost of developing, administering, and scoring NAEP science hands-on tasks and compares it to the cost for multiple-choice items. She concludes that it takes about 23 percent more staff time for hands-on tasks than multiple-choice. Additionally, it costs $2 to $6 per hands-on kit.

(AL# 600.6COSPEA)

O'Sullivan, Christine Y., Clyde M. Reese, and John Mazzeo. ***NAEP 1996 Science Report Card for the Nation and the States—Findings from the National Assessment of Educational Progress*****, May 1997. Available from: National Library of Education, Office of Educational Research and Improvement, U.S. Department of Education, 555 New Jersey Ave., NW, Washington, DC 20208, (800) 424-1616, (202) 219-1651. Also available: http://www.ed.gov/NCES/naep**

The 1996 NAEP science assessment contained multiple-choice, short answer (a few words to a couple of sentences), a longer response (one to two paragraphs, or a diagram, graph, or calculations), and hands-on (20 minute) tasks. Some of the tasks required equipment. Short and longer answer questions were scored on a three-point scale (complete, essential, partial). Hands-on activities had several parts, each of which was scored on a three-point (complete, partial, or incorrect), or four-point (complete, essential, partial, or incorrect) scale. Questions were designed to cover the NAEP content framework: three fields of science (earth, physical, and life), three elements of knowing and doing science (conceptual understanding, scientific investigation, and practical reasoning), and two overarching domains (the nature of science and themes). Questions were mix-and-matched onto several forms which also included student background questions, classroom learning activities (hands-on, courses taken, availability of resources, and attitude toward science), and opinions about the assessment.

In contrast to other content areas, the manner in which NAEP science scales are set up precludes the ability to track progress over time or judge if performance is "good enough." Results are described in terms of what students can do in each grade level (4, 8, and 12) and comparisons between different regions of the country and groups of students. For example, in the 1996 assessment, males and females performed the same at grades 4 and 8; at grade 12, males did better than females.

The report includes detailed results, a description of the NAEP science description and several scored samples of student work relating to three hands-on tasks and six short-answer questions. Complete technical information is available.

(AL# 600.6NAEP96b)

Padian, Kevin. *Improving Science Teaching: The Textbook Problem.* Located in: Skeptical Inquirer 17, Summer 1993, pp. 388-393.

Although not strictly about assessment, this article is included because it discusses the nature of the tasks and activities that we give students to do. One of the major points of the article is that giving students "hands-on" activities doesn't ensure "good" activities. If we don't craft our tasks to get at the heart of what we want to accomplish with students, the tasks will be worthless both as instruction and assessment tools.

(AL# 600.6IMPSCT)

Perlman, Carole. *The CPS Performance Assessment Idea Book,* November 1994. Available from: Chicago Public Schools, 1819 W. Pershing Rd., Chicago, IL 60609.

This handbook was developed to assist educators in developing performance assessments. Its most notable feature is a bank of over 90 sets of rubrics for assessing student performance in various grade levels and subject areas—reading, writing, mathematics, science, social studies, and fine arts. There are also well written sections on how to develop rubrics and performance tasks, and how to evaluate the quality of rubrics and performance tasks.

(AL# 000.3CPSPEA)

Pine, Jerome, Gail Baxter, and Richard J. Shavelson. ***Assessments for Hands-On Elementary Science Curricula,*** **1991. Available from: Physics Department, California Institute of Technology, Pasadena, CA 91125, (818) 356-6811.**

The authors present the case that science curriculum should enable students to learn how to pursue an experimental inquiry, and should give them the ability to construct new knowledge from their observations. Assessment should match this, but the authors question whether it is *always* necessary to have hands-on assessment tasks. The authors designed a study that compared observer rating of fifth- and sixth-grade student performance of hands-on tasks with five other surrogates: ratings of student lab notebooks, a computer simulation, free-response paper and pencil questions, multiple-choice items, and California Test of Basic Skills (CTBS) scores. The surrogates (with the exception of the CTBS) were designed to parallel the hands-on tasks as closely as possible.

Results showed:

1. It was possible to get consistent ratings of student performance on hands-on tasks with trained observers

2. Ratings of lab notebooks were a promising surrogate for observations, but they have to be designed carefully

3. Computer simulations, open-ended questions, and multiple-choice questions were not good surrogates

4. CTBS scores were moderately related to hands-on performance, but appeared to mainly reflect general verbal and numerical skills

5. In order to assess inquiry instruction rather than general natural ability, hands-on tasks need to be carefully designed

The paper briefly describes all the tasks used in the study, but does not present them in enough detail to replicate. A companion paper, *New Technologies for Large-Scale Science Assessments: Instruments of Educational Reform* (AL# 600.3NEWTEF), describes the tasks in more detail.

(AL# 600.3ASSFOH)

Pomeroy, Deborah. ***Implications of Teachers' Beliefs About the Nature of Science: Comparison of the Beliefs of Scientists, Secondary Science Teachers, and Elementary Science Teachers.*** **Located in: Science Education 77, June 1993, pp. 261-278.**

The author reports on a study that asked the question: "Are there differences between how scientists and teachers view the nature of science, scientific methodology, and related aspects of science education?" She developed a 50-item survey which covered: (1) the nature of scientific inquiry—is the only valid way of gaining scientific knowledge through inductive methods using controlled experimentation, or is there a role, as more contemporary views have it, for dreaming, intuition, play, and inexplicable leaps? (2) what K-12 science education should be like, and (3) background information on respondents. The complete survey and discussion of the results are included in the article.

(AL# 600.4TEABEA)

Porter, Andrew C. ***Standard Setting and the Reform of High School Mathematics and Science,*** **1995. Available from: Wisconsin Center for Education Research, School of Education, University of Wisconsin-Madison, 1025 W. Johnson St., Madison, WI 53706, (608) 263-4200.**

The author reports on a study of the effects of increased enrollment in academic classes resulting from raising course-taking graduation requirements. Previous studies discovered that increased graduation requirements did not raise dropout rates and that, indeed, students were taking more academic classes, especially science and math. This study examined whether the affected academic courses were "watered down" to accommodate weaker and less motivated students. The author found that courses were not watered down. The conclusion is that standards for high school students have, indeed, been raised.

(AL# 000.6STASER)

Psychological Corporation, The. ***GOALS: A Performance-Based Measure of Achievement—Science,*** **1992. Available from: The Psychological Corporation, Order Service Center, PO Box 839954, San Antonio, TX 78283, (800) 228-0752.**

GOALS is a series of short-answer questions (only one right answer) that can be used alone or in conjunction with the MAT-7 and SAT-9. Three forms are available for 11 levels of the test covering grades 1-12 for each of science, math, social studies, language and reading. Each test (except language) has ten items. On the science test, tasks cover content from the biological, physical, and earth/space sciences. Each task seems to address the ability to use a discrete science process skill (e.g., draw a conclusion, record data) or use a piece of scientific information. The tasks require students to answer a question and then (usually) provide an explanation.

Responses are scored on a four-point holistic scale (0-3) which emphasizes the degree of correctness or plausibility of the response and the clarity of the explanation. A generalized scoring guide is applied to specific questions by illustrating what 3, 2, 1 and 0 responses look like. Both norm-referenced and criterion-referenced (how students look on specific concepts) score reports are available. Scoring can be done either by the publisher or locally. A full line of report types (individual, summary, etc.) are available. The materials we obtained did not furnish any technical information about the test itself.

(AL# 610.3GOALSS)

Psychological Corporation, The. ***Integrated Assessment System—Science Performance Assessment,*** **1992. Available from: The Psychological Corporation, Order Service Center, PO Box 839954, San Antonio, TX 78283, (800) 228-0752.**

This is a series of seven tasks designed to be used with students in grades 2-8 (one task per grade level). The tasks involve designing and conducting an experiment based on a problem situation presented in the test. Students may work individually or in teams, but all submitted products must be individually generated. Students generate a hypothesis they wish to test, write down (or show using pictures) the procedures used in the experiment, record data, and draw conclusions. At the end, students are asked to reflect on what they did and answer questions such as: "What problem did you try to solve?" "Tell why you think things worked the way they did," and "What have you seen or done that reminds you of what you have learned in the experiment?" The final question in the booklet asks students how they view science. This question is not scored but can be used to gain insight into students' performances.

Only the written products in the answer booklet are actually scored. (However, the publisher recommends that teachers watch the students as they conduct the experiment to obtain information about process. A checklist of things to watch for is provided.) Responses can be scored either holistically or analytically using general criteria. The holistic scale (0-6) focuses on the quality of work, conceptual understanding, logical reasoning, and ability to communicate what was done. The four analytical traits are: experimenting (ability to state a clear problem, and then design and carry out a good experiment), collecting data (precise and relevant observations), drawing conclusions (good conclusions supported by data), and communicating (use of appropriate scientific terms, and an understandable presentation of what was done.). Traits are scored on a scale of 1-4.

In the materials we obtained, there are no student performances provided to illustrate the scoring. No technical information about the assessment is included.

(AL# 600.3INTASS)

BEST COPY AVAILABLE

Raizen, Senta, and J. Kaser. ***Assessing Science Learning in Elementary School: Why, What, and How?*** **Located in: Phi Delta Kappan, May 1989, pp. 718-722.**

This paper describes some of the limitations of past standardized, multiple-choice tests to assess science, discusses how this combines with inadequate teacher preparation and textbooks to create inferior science instruction, and provides a list of questions to ask about any test being considered for use. The list of questions includes such things as "Are problems with more than one correct solution included?" and "Are there assessment exercises that encourage students to estimate their answers and to check their results?"

(AL# 600.6ASSSCL)

Regional Educational Laboratories. ***Improving Classroom Assessment—A Toolkit for Professional Developers (Toolkit98),*** **1998. Available from: Document Reproduction, Northwest Regional Educational Laboratory, 101 SW Main St., Suite 500, Portland, OR 97204, (503) 275-9519, fax (503) 275-0458, Internet: http://www.nwrel.org**

The 1300-page *Toolkit98* was designed cooperatively by all 10 regional labs as a teacher professional development resource. It is a compilation of activities and supportive materials that serve both as an alternative assessment resource and a means of engaging teachers in dialogue about changing traditional teaching and assessment practices. *Toolkit98* contains:

- Information and 87 professional development activities on the topics of: rationale for alternative assessment, integrating assessment and instruction, design options for alternative assessment, being a critical consumer of assessments, and grading/reporting
- Forty-eight sample assessments of skills in science, mathematics, social studies, reading, writing, oral communication, and critical thinking
- Seven samples of student work used in various training activities
- Thirteen articles on grading and reporting

(AL# 000.6TOOKIP8)

Riggs, Iris M. and Larry G. Enochs. ***Toward the Development of an Elementary Teacher's Science Teaching Efficacy Belief Instrument,*** **1989. Available from: ERIC ED 308 068.**

This publication reports on a study in which the Personal Science Teaching Efficacy Belief Scale and the Science Teaching Outcome Expectancy Scale were administered to measure teacher feelings of self-efficacy and outcome expectancy. The authors present evidence that the combined instrument is valid for studying elementary teacher's beliefs toward science teaching and learning. The instrument is included.

(AL# 600.4TOWDEE)

Roth, Wolff-Michael. *Dynamic Evaluation.* Located in: Science Scope 15, March 1992, pp. 37-40.

The author describes a method by which students plan and report experiments: the Vee Map. The Vee Map requires students to list vocabulary related to the topic they are reporting, develop a concept map of these terms, describe the experimental design, describe the data collected, and present their conclusions. One extended example in earth science is given. Performance criteria for assessing Vee Maps are sketchy. No technical information is included.

(AL# 630.6DYNEVA)

Ruiz-Primo, Maria Araceli, and Richard J. Shavelson. ***Rhetoric and Reality in Science Performance Assessments: An Update.*** **Located in: Journal of Research in Science Teaching 33, 1996, pp. 1045-1063.**

The authors summarize current research on the reliability and validity of performance assessments, provide sound suggestions for the development of science performance assessments, list a good set of criteria for evaluating the quality of performance assessments, and discuss a set of dimensions along which sound performance assessments differ and why we should care. Some interesting points include:

- It is possible to train raters to be highly consistent in their scoring (inter-rater reliability).
- One would need 8-23 performance tasks to obtain a stable estimate of individual student achievement; 7-15 tasks for groups of 25 students or more.
- Initiation of performance assessment doesn't automatically affect instruction; teachers who already use inquiry-based methods have the most success.
- Task and scoring variations influence the extent to which performance assessments assess higher-order thinking skills.
- Issues of fairness and equity go beyond superficial fixes such as translating an assessment into a foreign language or just using a performance assessment; the issue is broader and reflects instructional and social problems that go beyond the type of assessment used.
- Teachers frequently think of performance assessments as anything that requires students to manipulate materials when, actually, sound performance assessment requires revisiting goals for students and designing tasks and scoring systems that reinforce the goals.

(AL# 600.6RHERES)

Schunk, Dale H. *Goal and Self-Evaluative Influences During Children's Cognitive Skill Learning*. Located in: American Educational Research Journal 33, Summer 1996, pp. 359-382. Also available from: Author, Department of Educational Studies, Purdue University, 1446 LAEB, Room 5108, West Lafayette, IN 47907.

The author reports on two studies of how student perception of the goals of instruction and opportunity to self-evaluate affect motivation and achievement. In both studies, fourth-grade students received instruction on fractions over several sessions. Half of the students were told that the goal of the sessions was to *learn how to* problem solve; the other half were merely told to solve the problems. Within each group, half of the students evaluated their own problem-solving capabilities and half did not. Results showed that students who were told the goal was learning to solve problems (regardless of whether they self-evaluated) and the students who just did the problems *and* self-evaluated did better than students who *neither* self-evaluated nor were told the goal was learning to solve problems. The conclusion? Students who know *why* they are doing something and students who self-evaluate do better.

(AL# 050.6GOASEI)

Scottish Examination Board. *Standard Grade—Amended Arrangements in Biology,* 1992. Available from: Dr. David M. Elliot, Director of Assessment, Ironmills Rd., Dalkeith, Midlothian, Edinburgh, EH22 1LE, Scotland, UK, (031) 663-6601.

The Scottish Examination Board prepares end-of-course tests for a variety of high school subjects to certify level of student competence. We have received tests for math, general science, and biology. The course syllabus for biology calls for coverage of: the biosphere, the world of plants, animal survival, investigating cells, the body in action, inheritance, and biotechnology. The goals of the course are: knowledge and understanding, problem solving, practical abilities, and attitudes. (Only the first three are assessed.) There are two main parts to the assessment for biology—written tests (developed by the Examination Board) and classroom embedded performance assessments (conducted by teachers according to specifications developed by the Examination Board).

The performance assessments cover techniques (students must demonstrate competence in ten areas such as "carrying out a test for starch") and investigations (students are scored for "generative skills," "experimentation skills," "evaluation skills," and "recording and reporting skills" on each of two investigations). Scoring entails assigning points for various specified features of performance, such as 2 points for "producing a table of results with suitable headings and units of measurement."

The package of materials we received included the course syllabus, specifications for the written and performance assessments, and copies of the written tests for 1993. It did not include technical information or sample student responses.

(AL# 640.3BIOSTG)

Scottish Examination Board. ***Standard Grade—Amended Arrangements in Science,*** **1992. Available from: Dr. David M. Elliot, Director of Assessment, Ironmills Rd., Dalkeith, Midlothian, Ediburgh, Scotland, EH22 1LE.**

The Scottish Examination Board prepares end-of-course tests for a variety of high school subjects to certify level of student competence. We have received tests for math, general science, and biology. The course syllabus for general science calls for coverage of: healthy and safe living, an introduction to materials, energy and its uses, and a study of environments. Goals are knowledge, problem solving, practical abilities (science process skills), and attitudes. (Only the first three are assessed.) There are two main parts to the assessment for general science written tests (developed by the Examination Board) and classroom embedded performance assessments (conducted by teachers according to specifications developed by the Examination Board).

The performance assessments cover techniques (students must demonstrate competence in eight areas such as "measuring pH") and investigations (students are scored for "generative skills," "experimentation skills," "evaluation skills," and "recording and reporting skills" on each of two investigations). Scoring entails assigning points for various specified features of performance, such as 2 points for "clearly identifying the purpose of the investigation in terms of the relevant variables."

The package of materials we received included the course syllabus, specifications for the written and performance assessments, and copies of the written tests for 1993. It did not include technical information or sample student responses.

(AL# 610.3SCISTG)

Semple, Brian McLean. ***Performance Assessment: An International Experiment,*** **1991. Available from: Educational Testing Service, The Scottish Office, Education Department, Rosedale Rd., Princeton, NJ 08541, (609) 734-5686.**

Eight math and eight science tasks were given to a sample of thirteen-year-olds in five volunteer countries (Canada, England, Scotland, USSR, and Taiwan). This sample was drawn from the larger group involved in the main assessment. The purpose of the assessment was to provide an information base to participating countries to use as they saw fit, and to examine the use of performance assessments in the context of international studies.

The 16 hands-on tasks are arranged in two 8-station circuits. Students spend about five minutes at each station performing a short task. Most tasks are "atomistic" in nature; they measure one small skill. For example, the 8 math tasks concentrate on measuring length, angles, and area, laying out a template on a piece of paper to maximize the number of shapes obtained, producing given figures from triangular cut-outs, etc. Some tasks require students to provide an explanation of what they did. All 16 tasks are included in this document, although some instructions are abbreviated and some diagrams are reduced in size. the complete tasks, administration and scoring guides are available from ETS. Most scoring is right/wrong; student explanations are summarized by descriptive categories. There is also observation of the products of students' work.

Student summary statistics on each task are included. There is a brief summary of teacher reactions, student reactions, the relationship between student performance on various tasks, and the relationship between performance on the multiple-choice and performance portions of the test. A few sample student performances are included.

(AL# 600.3PERASS)

Semple, Brian McLean. ***Science—Assessment of Achievement Programme, 1992.*** **Available from: Scottish Office Library, New St. Andrews House, Room 4/51a, Edinburgh, EH1 3SY, Scotland, UK, (031) 244-4388.**

The "Assessment of Achievement Programme (AAP)" was established by the Scottish Office of Education Department in 1981 to monitor the performance of pupils in grades 4, 7, and 9. This document reports on the 1990 science assessment. The assessment focused on science process skills: observing, measuring, handling information, using knowledge, using simple procedures, inferring, and investigating.

Assessment tasks used two formats: written (select the correct answer and provide a reason for the choice); and practical (use manipulatives to select the correct answer and provide a reason, or longer investigations such as observe an event and write down the observation). The practical portion was set up in (1) circuits of eight stations (four minutes at each station), or (2) longer investigations of 15-30 minutes. Detailed scoring guides are not provided in the materials we have. Student responses were apparently scored for both the correctness of the answer and the adequacy of the explanation.

The document we have describes the background of the assessment program, provides sample written and practical tasks for each skill area assessed, and describes student performance on the tasks (by grade level and gender, and over time). Neither technical information nor sample student performances are included.

(AL# 600.3SCAASA)

Serrano, Claudia. ***A Look at Portfolio Assessment in San Diego High School's Sophomore House,*** **1991. Available from: San Diego City Schools, 4100 Normal St., Room 3133, San Diego, CA 92103, (619) 298-8120.**

This paper describes an interdisciplinary (physics, math, and English) portfolio system for tenth graders that supports block scheduling in an inner city magnet school. Students keep a notebook of all work in each class. Class portfolios contain work selected from the notebook. Class portfolios are used as the basis for the culminating "House Portfolio" in which students select work to demonstrate that they have attained specified learning goals. The "House Portfolio" also includes written reflection and a final exhibition of mastery.

The document includes student instructions for assembling the portfolio, an entire student portfolio, instructions for a formal oral presentation of their portfolio, checklists and evaluation forms, and assistance with reflective writings and exit exhibitions. No technical information is included.

(AL# 000.3LOOPOA)

Shavelson, Richard J., Neil B. Carey, and Noreen M. Webb. ***Indicators of Science Achievement: Options for a Powerful Policy Instrument.*** **Located in: Phi Delta Kappan, May 1990, pp. 692-697.**

The authors review reasons for moving from multiple-choice tests of science achievement to more performance-based measures, and then discuss three examples: looking at how well students can move between different representation of a problem, mental models, and performance assessments/surrogates.

(AL# 600.6INDOFS)

Shavelson, Richard J., Gail P. Baxter, Jerry Pine, and J. Yure. ***New Technologies for Large-Scale Science Assessments: Instruments of Educational Reform,*** **1991. Available from: University of California, 552 University Rd., Santa Barbara, CA 93106, (805) 893-8000.**

This document is a series of papers that report in more detail on the studies of hands-on versus surrogate assessment tasks also described in *Assessments for Hands-On Elementary Science Curricula* (AL# 600.3ASSFOH). This includes more detailed descriptions of the three hands-on tasks (paper towels, sow bugs, and electric mysteries) and computer simulations. Findings, in addition to those reported in the companion paper, include:

1. Although observers could be trained to be very consistent in their ratings, a major source of error is still in the tasks chosen. That is, the decision about the level of an individual's performance depends greatly on the particular task used.

2. Hands-on assessment provides different information than that provided by paper and pencil tests.

(AL# 600.3NEWTEF)

BEST COPY AVAILABLE

Skaalvik, Einar M., and Richard J. Rankin. ***A Test of the Internal/External Frame of Reference Model at Different Levels of Math and Verbal Self-Perception.*** **Located in: <u>American Educational Research Journal</u> 32, Spring 1995, pp. 161-184.**

The authors report a study in which they looked at the relationship between math and verbal achievement and several different measures of motivation. The measures of motivation included a modified version of the *Self-Descriptive Questionnaire-II* (not included in the paper), and math (or verbal) self-concept, self-perceived aptitude, self-perceived ability to learn, intrinsic motivation, effort, and anxiety. The latter 74 questions are included in the paper. The authors found a strong relationship between the affective measures and student achievement. Technical information is included.

(AL# 500.3TESINE)

Small, Larry. ***Science Process Evaluation Model,*** **1992. Available from: Schaumburg Community Consolidated District #54, 524 E. Schaumburg Rd., Schaumburg, IL 60194, (708) 885-6700.**

This document contains a paper presented at a national conference in 1988 which briefly describes Schaumburg's science assessment system, and a set of tests for students in grades 4-6. The tests have three parts: multiple-choice to measure content and some process skills, self-report survey to assess attitudes toward science, and hands-on tasks to assess science process skills.

The hands-on part attempts to measure 11 student science process skills: observing, communicating, classifying, using numbers, measuring, inferring, predicting, controlling variables, defining operationally, interpreting data, and experimenting. It consists of students using manipulatives to answer fixed questions such as "Which drop magnifies the most?" or "Which clay boat would hold the most weights and still float in the water?" Students respond by choosing an answer (multiple-choice), supplying a short answer, or, in a few cases, drawing a picture or graph. Complete tests for Grades 4, 5, and 6 are included. No scoring procedures nor technical information were included with the package.

(AL# 600.3SCIPRE)

Smist, Julianne M., Francis X. Archambault, and Steven V. Owen. ***Gender Differences in Attitude Toward Science,*** **1994. Available from: Julianne M. Smist, Biology/Chemistry Department, Springfield College, Springfield, MA 01109.**

The authors report a study on how the *Test of Science-Related Attitudes* (TOSRA), developed in Australia, works with American high school students. The TOSRA has 70 questions that cover attitudes toward science, preference for experimentation, social implications of science, normality of scientists, attitude toward science classes, and openness to new ideas. The authors conclude that the TOSRA is a valid and reliable instrument for use with American students. TOSRA questions, and the subscales they relate to, are included, but need to be reformatted for use.

(AL# 600.3GENDIA)

Stage, Elizabeth K. ***Assessment in Science: Return to the Good Old Days?*** **Located in: The Clearing House 68, March/April 1995, pp. 215-218.**

The author describes past and current trends in science curriculum and instruction and the role of performance assessments and portfolios in documenting skill. The author then describes the New Standards Project plans for performance assessment in science and the rationale and questions to be addressed. No actual sample assessment tasks are included.

(AL# 600.6ASSSCR)

Stecher, Brian. ***The Cost of Performance Assessment in Science: The RAND Perspective,*** **1995. Available from: RAND, 1700 Main St., PO Box 2138, Santa Monica, CA 90407.**

This paper describes a study of the costs of performance assessments in science. Tasks (1) used manipulatives, (2) took 30-55 minutes, (3) required the manipulation of scientific equipment or materials, and (4) resulted in paper and pencil responses. The analysis looked at costs for development, preparation of equipment, task administration, scoring, personnel time, travel, and other costs. The authors concluded that such tests are about 100 times more expensive (± $30/student) than a standardized, multiple-choice test lasting 30 minutes, and 5-6 times more expensive than a typical direct writing assessment.

(AL# 600.6COSPER)

Surber, John R., Philip L. Smith, Frederika Harper. ***MAP Tests*****, 1981. Available from: John R. Surber, University of Wisconsin-Milwaukee, Department of Educational Psychology, Milwaukee, WI 53201, (414) 229-1122.**

Our review is based on four reports from the author: *Testing for Misunderstanding* (John R. Surber and Philip L. Smith, Educational Psychologist, 1981, 16, 3, pp. 165-174; *Technical Report No. 1, Structural Maps of Text as a Learning Assessment Technique: Progress Report for Phase I;* Surber, Smith, and Frederika Harper, undated, University of Wisconsin-Milwaukee; *Technical Report No. 6, The Relationship Between Map Tests and Multiple Choice Tests,* Surber, Smith and Harper, 1982, University of Wisconsin-Milwaukee.

These reports and papers describe the development of map tests as an assessment technique to identify conceptual misunderstandings that occur when students learn from text. The purpose is to diagnose student understanding in order to plan instruction. In this testing technique, the test developer graphically represents concepts and their interrelationships in a map. Then, information from the map is systematically removed. Students complete the map shells. Four different levels of deletion associated with different types of content clues are described. Maps are scored by comparing the student-completed version to the original. Scoring involves looking both at the content included or omitted from the map and the proper relationship between this content. Report #6 describes scoring in more detail.

The authors did a series of studies on this technique, reported on in "Mapping as a Testing and Diagnostic Device." They found good interrater reliability and good consistency between developers of "master maps." They report on comparisons to multiple-choice tests.

Text maps and tests can be constructed in any content area at any grade level. The specific examples in these materials come from chemistry (matter), study skills, and sociology (the development of early warfare).

A manual, designed to teach students how to construct concept maps, is included in Report #1. The authors have given educators permission to copy these documents for their own use.

(AL# 150.6MAPTES)

Tamir, Pinchas. *Science Assessment.* Located in: Menucha Birenbaum and Filip J. R. C. Dochy, Eds., <u>Alternatives in Assessment of Achievements, Learning Processes and Prior Knowledge</u>, 1996, pp. 93-129. Available from: Kluwer Academic Publishers, 101 Philip Dr., Assinippi Park, Norwell, MA 02061, (617) 871-6300, fax: (617) 878-0449.

The authors provide a nice discussion of various assessment approaches that can be used to assess student understanding of science (rather than just rote recall):

1. Enhanced multiple-choice, in which students either provide the degree of confidence in their choice or provide justifications for their choice.

2. Self-assessment for use on the validity and reliability of a generic "Self-Report Knowledge Inventory." The teacher compiles a list of concepts and/or skills that students are to master and students rate themselves on each.

3. Concept maps, including a bit on scoring.

4. Concept Linking Propositions in which students are asked to "write a sentence which captures as well as you can the nature of the relationship between <u>X</u> & <u>Y</u>."

5. "Practical Tests" (performance assessment based in the laboratory). The author presents a taxonomy of laboratory skills and provides various examples of tasks and scoring mechanisms, including checklists and rubrics.

The author describes other assessment procedures (e.g., portfolios) and outcomes (affective) more briefly. Some of the discussions are a little dated and the author fails to note the need for performance criteria for *all* types of open-ended assessment. I would recommend this to fairly knowledgeable users looking for ideas.

(AL# 600.6SCIEAS)

Tamir, Pinchas. *Various articles.* Available from: School of Education and Israel Science Teaching Center, Hebrew University, Jerusalem, 91904, Israel.

This document includes several papers by the author that describe his work on "practical exams" in high school biology. Included are:

1. Discussion of the importance of such exams.

2. Examples of various tasks and associated performance criteria. Some performance criteria are task specific and some are general.

3. A listing of 21 skills, knowledge, and behaviors that can be measured through practical exams.

(AL# 600.3FOCSTA)

TIMSS U.S. National Research Center. *TIMSS United States,* Report No. 8, April 1998. Available from: Gilbert Valverde, Associate Director, TIMSS, 457 Erickson Hall, Michigan State University, East Lansing, MI 48824, (517) 353-7755, fax: (517) 432-1727, e-mail: valverde@pilot.msu.edu

This special report from the US National Research Center summarizes the high school results of the Third International Mathematics and Science Study (TIMSS). (The middle school report is included as a separate entry on this bibliography.) Twenty-three countries participated in the high school TIMSS study which examined student math and science knowledge. Results showed that US students in general are among the lowest one-third internationally. This article summarizes the results, but includes no sample test questions.

(AL# 600.6TIMHIS)

University of Cambridge. *AICE: An Introduction—Advanced International Certificate of Education*, 1996. Available from: The AICE Coordinator, University of Cambridge, Local Examinations Syndicate, 1 Hills Rd., Cambridge CB1 2EU, United Kingdom, phone (international): +44 1223 553311, fax (international): +44 1223 460278.

The *Advanced International Certificate of Education (AICE)* is an international pre-university curriculum and examination system. *AICE* is administered by the University of Cambridge Local Examinations Syndicate (UCLES). UCLES courses and assessments are available in mathematics and sciences, languages, and arts and humanities. These seem to be similar to advanced placement exams in the US.

The lending library has information about the courses and exams in English, Spanish, physics, music, art, and mathematics. Assessments use a variety of formats including on-demand essays and classroom-embedded portfolios. For example, the physics assessment consists of a variable number of short answer questions, five essays, and either a school-based experiment or two lengthy essays concerning science process skills (two hours). Experiments are rated along four dimensions (use of equipment, data collection, deductions from data, and experimental design) on six-point scales.

(AL# 000.3ADVINCt—text) and (AL# 000.6ADVINCv—video)

Vargas, Elena Maldonado and Héctor Joel Alvarez. ***Mapping Out Students' Abilities.*** **Located in: Science Scope 15, March 1992, pp. 41-43.**

The authors use concept maps to assess the knowledge structures students have on various concepts in science. They give some brief help on how to design a concept map, and more extensive help on how to score maps. Two examples are given: matter and photosynthesis.

(AL# 600.6MAPOUS)

Weiss, Iris R. ***Report of the 1993 National Survey of Science and Mathematics Education*****, 1994. Available from: Horizon Research, Inc., 111 Cloister Ct., Suite 220, Chapel Hill, NC 27514, (919) 489-1725, fax: (919) 493-7589, Internet: hri@horizon-research.com**

The 1993 National Survey of Science and Mathematics Education was designed to identify trends in the areas of teacher background and experience, curriculum and instruction, and the availability and use of instructional resources. A total of 6,120 science and mathematics teachers from 1,252 schools across the United States were selected for this survey. Among the questions addressed by the survey: (1) How well prepared are science and mathematics teachers in terms of both content and pedagogy? (2) To what extent do teachers support reform notions embodied in the *National Council of Teachers of Mathematics' Standards* and the *National Science Education Standards?* (3) What are teachers trying to accomplish in their science and mathematics instruction, and what activities do they use to meet these objectives? (4) What are the barriers to effective and equitable science and mathematics education?

All surveys are included in the report. Parts of these surveys might be useful to look at local preparation of teachers, classroom climate, etc.

(AL# 000.6REPNAS)

Weiss, Iris R. *The Status of Science and Mathematics Teaching in the United States—Comparing Teacher Views and Classroom Practice to National Standards.* **Located in: NISE Brief 1, June 1997. Available from: National Institute for Science Education, University of Wisconsin, 1025 W Johnson St., Madison, WI 53706, (608) 263-9250 or (608) 263-1028, fax (608) 262-7428, Internet: niseinfo@mail.soemadison.wisc.edu**

This six-page document presents a summary of a 1993 survey of science and mathematics instruction in the US. Some interesting results were:

- "Traditional" lecture/textbook methodologies continued to dominate science and mathematics instruction. For example, 94 percent of high school science and mathematics classes listened and took notes during presentations by the teacher at least once a week, and 60 percent did so on a daily basis.

- Students are not given equal opportunities to achieve high expectations.

- More than 90 percent of science and mathematics teachers at the elementary and middle school levels, and 86 percent at the high school level, indicated that students learn best when they study these subjects in the context of a personal or social application. Similarly, most supported hands-on instruction, indicating that activity-based experiences "are worth the time and expense for what students learn." There was, however, less support among teachers for some of the other tenets of current reform ideas.

Actual survey questions are not included.

(AL# 500.6STASCM)

Wiggins, Grant. *Performance Assessment in Action: The Best Secondary Case Studies from "Standards, Not Standardization,"* **and** *Performance Assessment in Action: The Best Elementary Case Studies from "Standards, Not Standardization,"* **1997. Available from: The Center on Learning, Assessment, and School Structure, CLASS, 65 S. Main St., Building B, Box 2-10, Pennington, NJ 08534, (609) 730-1199, Internet: http://www.classnj.org**

This excellent set of "do-it-yourself" development materials provides video clips of 12 classroom assessment situations and related activities that develop and expand notions of:

- The characteristics of quality classroom assessment

- How quality assessment can help students learn

- Feasibility

- Student involved assessment

- Good criteria and where they come from

- How to set standards

Elementary and secondary case studies are provided in separate volumes. Case studies cover science, mathematics, social studies, language arts, and foreign language.

(AL# 150.6PEASINe [elementary] **and AL# 150.6PEASINs** [secondary]**)**

Wiggins, Grant. ***The Futility of Trying to Teach Everything of Importance.*** **Located in: Educational Leadership, November 1989, pp. 44-48, 57-59.**

Assessment has to reflect what we value. This article presents a philosophy for science instruction that has implications for assessment. Specifically, the author maintains that the goal of education should not be to teach every fact that we think students will need to know, because this will be impossible to do. Rather, we should concentrate on developing those habits of mind and high standards of craftsmanship that will enable students to be lifelong learners and critical thinkers. The article briefly mentions some of the implications for assessment of this philosophy.

(AL# 600.6FUTTRT)

Yee, Gary, and Michael Kirst. ***Lessons from the New Science Curriculum of the 1950s and 1960s.*** **Located in: Education and Urban Society 26, February 1994, pp. 158-171.**

The title of this article says it all—what we need to do differently in the current round of content standard development to avoid the pitfalls of past reform efforts.

(AL# 600.5LESFRN)

Electronic Resources

The following entries are separated from the papers and documents above because they do not involve actual Test Center holdings. Rather, they are electronic discussion groups and bulletin boards available over the Internet.

Science, Mathematics, and Technology Education. Facilitator: Dennis W. Cheek, Coordinator of Math, Science, and Technology, Rhode Island Department of Education, 22 Hayes St., Room B-4, Providence, RI 02908, (401) 277-2821, fax: (401) 351-7874.

Promotes cross-disciplinary dialogue on issues such as scientific and technological literacy for all students; increasing participation of women and minorities in science, technology, and mathematics; nontraditional means of assessment; scope, sequence, and coordination of K-12 science, mathematics, and technology education. Also fosters collaboration on these topics with professional organizations: American Association for the Advancement of Science, the National Academy of Sciences, The National Academy of Engineering, The National Technical Association, etc.

Toby Levine Communications, Inc., 7910 Woodmont Ave., Suite 910, Bethesda, MD 20814, (301) 907-6510, fax: (301) 907-6916, e-mail: theguide@tobylevine.com

"On September 1, 1997, the Annenberg/CPB Projects launched its new World Wide Web Home Page, combining the extensive resources of its higher education project with those of its math and science project. *The Guide Online* is in its Interact section. This edition updates more than 120 reform initiatives and presents information on more than 150 new projects." The Internet address is http://www.learner.org/theguide

Science Bibliography

Index Codes

A—Type

1 = Example
2 = Theory/how to assess/rationale for alternative assessment
3 = Content/what should be assessed
4 = Related: general assessment; program evaluation; results of studies; technology; attitudes

B—Purpose for the Assessment

1 = Large scale
2 = Classroom
3 = Research

C—Grade Levels

1 = Pre K-K
2 = 1-3
3 = 4-6
4 = 7-9
5 = 10-12
6 = Adult
7 = Special education
8 = All
9 = Other

D—Content Covered

1 = General science
2 = Biology
3 = Chemistry
4 = Physics
5 = Earth/Space Science
6 = Other
7 = All/Any

E—Type of Tasks

1 = Enhanced multiple choice
2 = Constructed response: short answers
3 = Long response/essay
4 = On-demand
5 = Project
6 = Portfolio
7 = Group
8 = Other than written
9 = Cognitive map

F—Skills Assessed

1 = Knowledge/conceptual understanding
2 = Application of concepts
3 = Persuasion
4 = Critical thinking/problem solving; reasoning/decision making
5 = Group process skills
6 = Quality of writing/communication
7 = Student self-reflection
8 = Process
9 = Comprehension
10 = Student attitudes

G—Type of Scoring

1 = Task specific
2 = General
3 = Holistic
4 = Analytical Trait

DOE=Department of Education

A1Abraham (AL# 650.3UNDMIE)
A1Alberta Ed (AL# 600.3EVASTL)
A1Ancess (AL# 150.6SENPRA)
A1Appalachia Ed. Lab. (AL# 600.3ALTASM)
A1Badger & Thomas (AL# 600.3ONTHOS)
A1Baker (AL# 000.3CREPEA)
A1BC Mnstry. of Ed. (AL# 000.3BCPERA)
A1Beaton (AL# 600.6SCIACM)
A1Bennett (AL# 600.3ASSTEVh/v)
A1Berenson (AL# 600.6WRIOPE)
A1CA Assm. Coll. (AL# 150.6CHACOU)
A1CA Dept. of Ed. (AL# 600.3GOLSTB)
A1CA Dept. of Ed. (AL# 600.3SCINED)
A1CA DOE (AL# 600.3GOLSTE2)
A1CA DOE (AL# 600.6SCIASS)
A1Clarridge (AL# 150.6IMPNEE)
A1Colorado DOE (AL# 000.3STAASR)
A1Comfort (AL# 600.3SAMSCA
A1Council of Chief St. School (AL# 600.3COLDES)
A1CTB (AL# 060.3CAT5-a)
A1CTBS/Terra Nova (AL# 060.3TERNOV)
A1Curriculum Corp. (AL# 600.3SCICUA)
A1Curriculum Corp. (AL# 600.3TECCUA)
A1Doig (AL# 600.3EXEASM)
A1Doran (AL# 600.3ASSLAS)
A1Ed. Testing Service (AL# 000.3MISALA)
A1Everett (AL# 600.6PERASW2)
A1EXEMPLARS (AL# 600.3EXETES)
A1Ft. Hays Ed. Dev. Center (AL# 600.3SCIRUT)
A1Gayford (AL# 600.3CONTOM)
A1Gong (AL# 600.6INSASL)
A1Green (AL# 600.3PERBAA)
A1Greig (AL# 600.3DEVASS)
A1Hall (AL# 600.3JUSDOI)
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D3Beaton (AL# 600.6SCIACM)
D3CA DOE (AL# 600.3GOLSTB)
D3CA DOE (AL# 600.3GOLSTE2)
D3CTBS/Terra Nova (AL# 060.3TERNOV)
D3Doran (AL# 600.3ASSLAS)
D3Hibbard (AL# 600.3WHAHAP)
D3IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
D3Lock (AL# 600.6GENPRS)
D3Maine DOE (AL# 000.3GUIMAE)
D3O'Rafferty (AL# 600.3DESANP)
D3Riverside Pub. Co. (AL# 500.3CALPRL)
D3Univ. of Cambridge (AL# 000.3ADVINC)

D4Abraham (AL# 650.3UNDMIE)
D4Beaton (AL# 600.6SCIACM)
D4Bennett (AL# 600.3ASSTEVh/v)
D4CTBS/Terra Nova (AL# 060.3TERNOV)
D4Curriculum Corp. (AL# 600.3SCICUA)
D4Doran (AL# 600.3ASSLAS)
D4IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
D4KY DOE (AL# 060.3KIRIS94)
D4Lock (AL# 600.6GENPRS)
D4Maine DOE (AL# 000.3GUIMAE)
D4O'Rafferty (AL# 600.3DESANP)
D4Serrano (AL# 000.3LOOPOA)
D4Univ. of Cambridge (AL# 000.3ADVINC)

D5CA DOE (AL# 600.3SCINED)
D5CTBS/Terra Nova (AL# 060.3TERNOV)
D5Curriculum Corp. (AL# 600.3SCICUA)
D5Doig (AL# 600.3EXEASM)
D5KY DOE (AL# 600.3PEREVG)
D5Lawrence Hall of Science (AL# 600.3FOSSWM)
D5Lee (AL# 620.3DISPRS)
D5Maine DOE (AL# 000.3GUIMAE)
D5NY DOE(AL# 000.6MATSCT)
D5Univ. of Cambridge (AL# 000.3ADVINC)

D6Beaton (AL# 600.6SCIACM)
D6Curriculum Corp. (AL# 600.3TECCUA)
D6Hibbard (AL# 600.3WHAHAP)
D6Univ. of Cambridge (AL# 000.3ADVINC)

D7Ancess (AL# 150.6SENPRA)
D7Berenson (AL# 600.6WRIOPE)
D7CA DOE (AL# 600.6SCIASS)
D7Collins (AL# 600.6PORSCE)
D7Comfort (AL# 600.3SAMSCA
D7Comfort (AL# 600.6SAMSCA3)
D7Ed. Testing Service (AL# 000.3MISALA)
D7Fraser (AL# 600.3EVOVAP)
D7Ft. Hays Ed. Dev. Center (AL# 600.3SCIRUT)
D7Germann (AL# 210.3DEVATT)
D7Gong (AL# 600.6INSASL)
D7Hall (AL# 600.3JUSDOI)
D7Harcourt Brace (AL# 060.3STAACT9)
D7Kessler (AL# 000.3EVACOM)
D7McColskey (AL# 600.6HOWASS2)
D7Meng (AL# 600.6IMPINL)
D7Moen (AL# 000.3LANCOS)
D7Nat'l Academy of Sci. (AL# 600.5NATSCE3)
D7NWREL (AL# 600.6ASSSTI)
D7O'Malley (AL# 350.6AUTASE)
D7OR New Stand. Proj. (AL# 000.3STUPOQ)
D7O'Sullivan et al. (AL# 600.6NAEP96b)
D7Pine (AL# 600.3ASSFOH)
D7Reg. Ed. Lab. Net. Prog. (AL# 000.6TOOKIP8)
D7Shavelson (AL# 600.3NEWTEF)
D7Skaalvik & Rankin (AL# 500.3TESINE)
D7Smist (AL# 600.3GENDIA)
D7Surber (AL# 150.6MAPTES)
D7Tamir (AL# 600.6SCIEAS)
D7Vargas (AL# 600.6MAPOUS)

D8CA DOE (AL# 600.6SCIASS)

E1Beaton (AL# 600.6SCIACM)
E1CA DOE (AL# 600.3GOLSTB)
E1CA DOE (AL# 600.3GOLSTE2)
E1CA DOE (AL# 600.6SCIASS)
E1Comfort (AL# 600.3SAMSCA)
E1Comfort (AL# 600.6SAMSCA3)
E1Comfort (AL# 600.6SAMSCA3)
E1CTBS/Terra Nova (AL# 060.3TERNOV)
E1Meng (AL# 600.6IMPINL)
E1Ostlund (AL# 600.3SCIPRS)

E1Semple (AL# 600.3SCAASA)
E1Tamir (AL# 600.6SCIEAS)

E2Abraham (AL# 650.3UNDMIE)
E2Beaton (AL# 600.6SCIACM)
E2CA DOE (AL# 600.3GOLSTB)
E2CA DOE (AL# 600.3GOLSTE2)
E2CA DOE (AL# 600.3SCINED)
E2CA DOE (AL# 600.6SCIASS)
E2Comfort (AL# 600.3SAMSCA
E2Comfort (AL# 600.6SAMSCA3)
E2CTB (AL# 060.3CAT5-a)
E2CTBS/Terra Nova (AL# 060.3TERNOV)
E2Doig (AL# 600.3EXEASM)
E2Harcourt Brace (AL# 060.3STAACT9)
E2Hardy (AL# 600.3OPTSCP)
E2Hein (AL# 600.6ACTASA)
E2Hibbard (AL# 600.3WHAHAP)
E2IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
E2Kanis (AL# 600.3NINGRL)
E2KY DOE (AL# 600.3PEREVG)
E2Lawrence (AL# 000.6INTUTCv)
E2Lawrence (AL# 600.3UTACOC)
E2Lawrence Hall of Science (AL# 600.3FOSSWM)
E2Lee (AL# 620.3DISPRS)
E2Maine DOE (AL# 000.3GUIMAE)
E2McColskey (AL# 600.6HOWASS2)
E2MD Assm. Consort. (AL# 000.3PERAST)
E2MD DOE (AL# 600.3MSPAPS)
E2Meng (AL# 600.6IMPINL)
E2NWREL (AL# 600.6ASSSTI)
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E2O'Rafferty (AL# 600.3DESANP)
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E2Small (AL# 600.3SCIPRE)
E2Tamir (AL# 600.6SCIEAS)
E2Univ. of Cambridge (AL# 000.3ADVINC)

E3 Comfort (AL# 600.3SAMSCA)
E3 Gong (AL# 600.6INSASL)
E3 Green (AL# 600.3PERBAA)
E3Alberta Ed (AL# 600.3EVASTL)
E3Baker (AL# 000.3CREPEA)
E3Bennett (AL# 600.3ASSTEVh/v)
E3Berenson (AL# 600.6WRIOPE)
E3CA DOE (AL# 600.3GOLSTB)
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E3Comfort (AL# 600.6SAMSCA3)
E3CTB (AL# 060.3CAT5-a)
E3Doran (AL# 600.3ASSLAS)
E3Ed. Testing Service (AL# 000.3MISALA)
E3EXEMPLARS (AL# 600.3EXETES)
E3Ft. Hays Ed. Dev. Center (AL# 600.3SCIRUT)
E3Gayford (AL# 600.3CONTOM)
E3Greig (AL# 600.3DEVASS)
E3Hall (AL# 600.3JUSDOI)
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E3Hardy (AL# 600.3OPTSCP)
E3Hein (AL# 600.6ACTASA)
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E3KY DOE (AL# 060.3KIRIS94)
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E3NWREL (AL# 600.6ASSSTI)
E3NY DOE(AL# 000.6MATSCT)
E3O'Malley (AL# 350.6AUTASE)
E3O'Sullivan et al. (AL# 600.6NAEP96b)
E3Pine (AL# 600.3ASSFOH)
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E3Roth (AL# 630.6DYNEVA)
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E3Semple (AL# 600.3SCAASA)
E3Shavelson (AL# 600.3NEWTEF)
E3Surber (AL# 150.6MAPTES)
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E3Tamir (AL# 600.6SCIEAS)
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E4Baker (AL# 000.3CREPEA)
E4CA DOE (AL# 600.3GOLSTB)
E4CA DOE (AL# 600.3GOLSTE2)
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E4CA DOE (AL# 600.6SCIASS)
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E4Comfort (AL# 600.6SAMSCA3)
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E4CTB (AL# 060.3CAT5-a)
E4Doig (AL# 600.3EXEASM)
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E4Hall (AL# 600.3PERAST)
E4Hein (AL# 600.6ACTASA)
E4IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
E4Jones (AL# 600.6PERBAS)
E4Kanis (AL# 600.3NINGRL)
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E4Lawrence Hall of Science (AL# 600.3FOSSWM)
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E4Lock (AL# 600.6GENPRS)
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E4O'Rafferty (AL# 600.3DESANP)
E4Psychological Corp. (AL# 600.3INTASS)
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E5Alberta Ed (AL# 600.3EVASTL)
E5Ancess (AL# 150.6SENPRA)
E5Bennett (AL# 600.3ASSTEVh/v)
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E5Gayford (AL# 600.3CONTOM)
E5Gong (AL# 600.6INSASL)
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E5Hibbard (AL# 600.3WHAHAP)
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E5Meng (AL# 600.6IMPINL)
E5Moen (AL# 000.3LANCOS)
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E5Scottish Exam. Board (AL# 640.3BIOSTG)

E6CA DOE (AL# 600.6SCIASS)
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E6Comfort (AL# 600.3SAMSCA)
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E6IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
E6McColskey (AL# 600.6HOWASS2)
E6Moen (AL# 000.3LANCOS)
E6NWREL (AL# 600.6ASSSTI)
E6OR New Stand. Proj. (AL# 000.3STUPOQ)
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E6Serrano (AL# 000.3LOOPOA)
E6Tamir (AL# 600.6SCIEAS)

E7Alberta Ed (AL# 600.3EVASTL)
E7Bennett (AL# 600.3ASSTEVh/v)
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E7Doig (AL# 600.3EXEASM)
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E7Scottish Exam. Board (AL# 610.3SCISTG)
E7Tamir (AL# 600.6SCIEAS)

E8Alberta Ed (AL# 600.3EVASTL)
E8Arter (AL# 150.6INTASI)
E8Arter (AL# 150.6PERCRH)
E8CA DOE (AL# 600.3GOLSTB)
E8CA DOE (AL# 600.3GOLSTE2)
E8Doig (AL# 600.3EXEASM)
E8Doran (AL# 600.3ASSLAS)
E8Ed. Testing Service (AL# 000.3MISALA)
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E8Gong (AL# 600.6INSASL)
E8Green (AL# 600.3PERBAA)
E8Greig (AL# 600.3DEVASS)
E8Hall (AL# 600.3JUSDOI)
E8Hall (AL# 600.3PERAST)
E8Hibbard (AL# 600.3WHAHAP)
E8IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
E8Kanis (AL# 600.3NINGRL)
E8KY DOE (AL# 600.3PEREVG)
E8Lee (AL# 620.3DISPRS)
E8Lock (AL# 600.6GENPRS)
E8Martinello (AL# 600.3MAROPS)
E8MD Assm. Consort. (AL# 000.3PERAST)
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E8Meng (AL# 600.6IMPINL)
E8Moen (AL# 000.3LANCOS)
E8O'Malley (AL# 350.6AUTASE)
E8O'Rafferty (AL# 600.3DESANP)
E8O'Sullivan et al. (AL# 600.6NAEP96b)
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E8Semple (AL# 600.3SCAASA)
E8Tamir (AL# 600.3FOCSTA)
E8Tamir (AL# 600.6SCIEAS)

E9Gong (AL# 600.6INSASL)
E9Holley (AL# 150.6SPALES)
E9Kessler (AL# 000.3EVACOM)
E9NWREL (AL# 600.6ASSSTI)
E9O'Malley (AL# 350.6AUTASE)
E9Surber (AL# 150.6MAPTES)
E9Tamir (AL# 600.6SCIEAS)
E9Vargas (AL# 600.6MAPOUS)

E10Gong (AL# 600.6INSASL)
E10Pine (AL# 600.3ASSFOH)
E10Shavelson (AL# 600.3NEWTEF)

F1Abraham (AL# 650.3UNDMIE)
F1Ancess (AL# 150.6SENPRA)
F1Badger & Thomas (AL# 600.3ONTHOS)
F1Baker (AL# 000.3CREPEA)
F1Beaton (AL# 600.6SCIACM)
F1Bennett (AL# 600.3ASSTEVh/v)
F1CA DOE (AL# 600.3GOLSTB)
F1CA DOE (AL# 600.3GOLSTE2)
F1CA DOE (AL# 600.6SCIASS)
F1CA DOE (AL# 600.3SCINED)
F1Comfort (AL# 600.3SAMSCA)
F1Comfort (AL# 600.6SAMSCA3)
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F1Curriculum Corp. (AL# 600.3SCICUA)
F1Curriculum Corp. (AL# 600.3TECCUA)
F1Doig (AL# 600.3EXEASM)
F1Ed. Testing Service (AL# 000.3MISALA)
F1Everett (AL# 600.6PERASW2)
F1EXEMPLARS (AL# 600.3EXETES)
F1Hein (AL# 600.6ACTASA)
F1Hibbard (AL# 600.3WHAHAP)
F1IL Sci. Tchrs. Assn. (AL# 600.3SCIPAH)
F1Kessler (AL# 000.3EVACOM)
F1KY DOE (AL# 600.3PEREVG)
F1Maine DOE (AL# 000.3GUIMAE)
F1McColskey (AL# 600.6HOWASS2)
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F1MD DOE (AL# 600.3MSPAPS)
F1Meng (AL# 600.6IMPINL)
F1Nat'l Academy of Sci. (AL# 600.5NATSCE3)
F1O'Malley (AL# 350.6AUTASE)
F1OR New Stand. Proj. (AL# 000.3STUPOQ)
F1O'Sullivan et al. (AL# 600.6NAEP96b)
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F1Scottish Exam. Board (AL# 640.3BIOSTG)
F1Surber (AL# 150.6MAPTES)
F1Tamir (AL# 600.3FOCSTA)
F1Tamir (AL# 600.6SCIEAS)
F1Vargas (AL# 600.6MAPOUS)

F2Baker (AL# 000.3CREPEA)
F2Beaton (AL# 600.6SCIACM)
F2CA DOE (AL# 600.3GOLSTB)
F2CA DOE (AL# 600.3GOLSTE2)
F2CA DOE (AL# 600.3SCINED)
F2CA DOE (AL# 600.6SCIASS)
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F2CTBS/Terra Nova (AL# 060.3TERNOV)
F2Curriculum Corp. (AL# 600.3SCICUA)
F2Curriculum Corp. (AL# 600.3TECCUA)
F2Doig (AL# 600.3EXEASM)
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F2Hein (AL# 600.6ACTASA)
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F2Riverside Publishing Co.(AL# 500.3CALPRL)
F2Scottish Exam. Board (AL# 640.3BIOSTG)
F2Tamir (AL# 600.3FOCSTA)
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F3Baker (AL# 000.3CREPEA)
F3CA DOE (AL# 600.6SCIASS)
F3MD Assm. Consort. (AL# 000.3PERAST)
F3Reg. Ed. Lab. Net. Prog. (AL# 000.6TOOKIP8)

F4Alberta Ed (AL# 600.3EVASTL)
F4Ancess (AL# 150.6SENPRA)
F4Beaton (AL# 600.6SCIACM)
F4Bennett (AL# 600.3ASSTEVh/v)
F4CA DOE (AL# 600.3GOLSTB)
F4CA DOE (AL# 600.3GOLSTE2)
F4CA DOE (AL# 600.6SCIASS)
F4Comfort (AL# 600.6SAMSCA3)
F4CTBS/Terra Nova (AL# 060.3TERNOV)
F4Curriculum Corporation (AL# 600.3SCICUA)
F4Curriculum Corporation (AL# 600.3TECCUA)
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F4Everett (AL# 600.6PERASW2)
F4EXEMPLARS (AL# 600.3EXETES)
F4Ft. Hays Ed. Dev. Center (AL# 600.3SCIRUT)
F4Green (AL# 600.3PERBAA)
F4Hall (AL# 600.3JUSDOI)
F4Hall (AL# 600.3PERAST)
F4Hein (AL# 600.6ACTASA)
F4Hibbard (AL# 600.3WHAHAP)
F4Kanis (AL# 600.3NINGRL)
F4KY DOE (AL# 600.3PEREVG)
F4Macdonald Educational (AL# 600.6LEATHS)
F4Macdonald Educational (AL# 600.6WITOBM)
F4Maine DOE (AL# 000.3GUIMAE)
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F4O'Sullivan et al. (AL# 600.6NAEP96b)
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F4Reg. Ed. Lab. Net. Prog. (AL# 000.6TOOKIP8)
F4Riverside Publishing Co.(AL# 500.3CALPRL)
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F4Small (AL# 600.3SCIPRE)
F4Tamir (AL# 600.3FOCSTA)
F4Tamir (AL# 600.6SCIEAS)

F5Alberta Ed (AL# 600.3EVASTL)
F5Bennett (AL# 600.3ASSTEVh/v)
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F5Scottish Exam. Board (AL# 610.3SCISTG)

F6Ancess (AL# 150.6SENPRA)
F6Bennett (AL# 600.3ASSTEVh/v)
F6CA DOE (AL# 600.3GOLSTB)
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F6CA DOE (AL# 600.6SCIASS)
F6Comfort (AL# 600.3SAMSCA)
F6Comfort (AL# 600.6SAMSCA3)
F6Ed. Testing Service (AL# 000.3MISALA)
F6ETS (AL# 150.6CAPPOC)
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F6EXEMPLARS (AL# 600.3EXETES)
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F6Hall (AL# 600.3JUSDOI)
F6Hall (AL# 600.3PERAST)
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F6MD Assm. Consort. (AL# 000.3PERAST)
F6MD DOE (AL# 600.3MSPAPS)
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